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# **PREDICTING SUICIDE ATTEMPT AND SUICIDE – THE ROLE OF STANDARDISED INSTRUMENTS IN A PSYCHIATRIC COHORT**

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# Predicting suicide attempt and suicide – the role of standardised instruments in a psychiatric cohort

## THESIS FOR DOCTORAL DEGREE (Ph.D.)

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“Will they die?”

“Difficult to see. Always in motion is the future.”

*Luke Skywalker and Yoda in Star Wars: Episode V*



# ABSTRACT

## Aim

The aim of this thesis was to assess the role of standardised instruments in prediction of suicide attempt and suicide in patients known to have an increased risk of these outcomes, namely patients with self-harm.

## Method

The predictive abilities of four instruments focusing on different factors related to suicide risk were estimated using a sample of patients with a recent episode of self-harm with or without suicidal intent (N=804) who took part in a prospective, observational multicentre study. Patients were identified at psychiatric or medical emergency departments and interviewed by research staff not engaged in the regular clinical management. The outcomes of interest were suicide attempt and suicide within one year of the index episode. Follow-up data was collected from medical records and the National Cause of Death Register. Correlations between total scores of the instruments (or dichotomised total scores) and the outcomes were evaluated using the  $\chi^2$ -test, logistic regression and receiver operating characteristic curves. The Karolinska Interpersonal Violence Scale (KIVS) was used to assess experience of interpersonal violence, and the total score was examined as a predictor of repeat non-fatal or fatal attempt within six months in 355 participants included after a suicide attempt from 2012 to 2014 (*Study I*). The Columbia-Suicide Severity Rating Scale (C-SSRS) was used to assess suicidal ideation and behaviour and examined as a predictor of repeat non-fatal or fatal attempt within six months in the full sample (N=804) included between 2012 and 2016 (*Study II*). The KIVS, the C-SSRS, the Suicide Intent Scale (SIS) and the Suicide Assessment Scale (SUAS) were compared regarding predictive accuracy measures for suicide attempt and suicide as separate outcomes within three months and one year (*Study III*). The predictive accuracy of the clinical suicide risk assessment was compared to that of SIS in a subset of the sample (n=479) for the outcome suicide within one year (*Study IV*).

## Results

The non-fatal one-year repetition rate was 27% and the fatal repetition rate was 2.4%. Statistically significant correlations were found between the total scores of the KIVS, the C-SSRS and the SUAS and non-fatal suicide attempts within six months and one year follow-up (*Study I, II and III*). Predictive accuracy was limited for all instruments. The same applied to the SIS total score predicting suicide within three months and one year (*Study III*). The predictive abilities were very similar for the SIS and the clinical risk assessment regarding suicide during one-year follow-up, again with limited accuracy measures (*Study IV*).

## Conclusions

Due to limited accuracy measures and the low base rates of suicide attempt and suicide, these instruments cannot be of clinically practical use in the prediction of suicide attempt and suicide on an individual level. Other potential areas of usage for the instruments, such as structuring clinical data, exploring specific experiences or monitoring symptoms, remain to be examined.

## LIST OF SCIENTIFIC PAPERS

- I. Axel Haglund, **Åsa U. Lindh**, Henrik Lysell, Ellinor Salander Renberg, Jussi Jokinen, Margda Waern, Bo Runeson. Interpersonal violence and the prediction of short-term risk of repeat suicide attempt. *Scientific Reports*, 2016, 6:36892
- II. **Åsa U. Lindh**, Margda Waern, Karin Beckman, Ellinor Salander Renberg, Marie Dahlin, Bo Runeson. Short term risk of non-fatal and fatal suicidal behaviours: The predictive validity of the Columbia-Suicide Severity Rating Scale in a Swedish adult psychiatric population with a recent episode of self-harm. *BMC Psychiatry*, 2018, 18:319
- III. **Åsa U. Lindh**, Marie Dahlin, Karin Beckman, Lotta Strömsten, Jussi Jokinen, Stefan Wiktorsson, Ellinor Salander Renberg, Margda Waern, Bo Runeson. A comparison of suicide risk scales in predicting repeat suicide attempt and suicide. A clinical cohort study. *Submitted*.
- IV. **Åsa U. Lindh**, Karin Beckman, Andreas Carlborg, Margda Waern, Ellinor Salander Renberg, Marie Dahlin, Bo Runeson. Assessment of suicide risk by the clinical global evaluation – Is there any evidence? *Manuscript*.



# CONTENTS

1	Introduction.....	1
1.1	Terminology.....	1
1.2	Epidemiology.....	3
1.2.1	Global estimates.....	3
1.2.2	Swedish statistics .....	5
1.3	Correlates and risk factors of suicide attempt and suicide .....	7
1.3.1	Biological markers .....	7
1.3.2	Experience of interpersonal violence.....	7
1.3.3	Psychiatric and other disorders.....	8
1.3.4	Symptoms and cognitive features.....	9
1.3.5	Interpersonal problems .....	9
1.3.6	Previous self-harm .....	9
1.3.7	Specific risk factors for repetition?.....	9
1.4	Understanding suicide.....	10
1.5	Standardised instruments used in suicide risk assessment.....	11
1.5.1	Responding and reacting to questions about suicidality.....	12
2	Aims .....	15
3	Material and methods.....	17
3.1	Cohort studies.....	18
3.2	Data collection .....	18
3.2.1	The multicentre study .....	18
3.2.2	Baseline data.....	19
3.2.3	Outcome data .....	22
3.3	Statistical analyses.....	23
3.4	Ethical considerations .....	25
3.4.1	Taking part in a study – comments from the participants .....	26
3.4.2	Interviewing for a study – reflections from a clinician .....	26
4	Results .....	27
4.1	Study I: Interpersonal violence as predictor of suicide attempt .....	29
4.2	Study II: Suicidal ideation and behaviour as predictor of suicide attempt.....	29
4.3	Study III: Comparison of predictive accuracy of standardised instruments.....	29
4.4	Study IV: Clinical suicide risk assessment vs Suicide Intent Scale.....	30
4.5	Internal consistency and interrater reliability.....	31
5	Discussion.....	33
5.1	Methodological considerations.....	33
5.1.1	Population and study sample.....	33
5.1.2	Identifying the outcome.....	34
5.1.3	General considerations .....	35
5.2	Interpersonal violence assessed with the KIVS .....	35
5.3	Suicidal ideation and behaviours assessed with the C-SSRS.....	36
5.4	Comparison of the rating scales.....	38

5.5	The clinical suicide risk assessment and SIS .....	39
5.6	Why is it so difficult to predict suicide attempt and suicide? .....	40
5.6.1	A suicidal act is the result of a temporary state of mind.....	40
5.6.2	Suicide is a rare event .....	40
5.6.3	The problem with a low PPV .....	42
5.6.4	The low predictive accuracy of the major risk factors.....	42
5.6.5	The low predictive accuracy of many risk factors in combination .....	43
5.6.6	Barriers to perfect clinical predictions .....	44
5.6.7	Big data and machine learning cannot circumvent the low base rate.....	44
5.7	Hindsight bias, and prediction outside psychiatry .....	46
6	Conclusions and practical implications .....	49
7	Svensk sammanfattning.....	51
8	Acknowledgements.....	55
9	References .....	57

## LIST OF ABBREVIATIONS

AUC	Area Under the Curve
C-CASA	Columbia Classification Algorithm of Suicide Assessment
CDC	Centers for Disease Control and Prevention
C-SSRS	Columbia-Suicide Severity Rating Scale
FDA	Food and Drug Administration
HR	Hazard Ratio
ICD-10	International Statistical Classification of Diseases and Related Health Problems, 10th Revision
KIVS	Karolinska Interpersonal Violence Scale
NASP	National Centre for Suicide Research and Prevention of Mental Ill-Health
NICE	National Institute of Health and Care Excellence
NPV	Negative Predictive Value
NSSI	Non-Suicidal Self-Injury
OR	Odds Ratio
PABAK	Prevalence-Adjusted, Bias-Adjusted Kappa
PPV	Positive Predictive Value
ROC	Receiver Operating Characteristics
SB	Suicidal Behaviour
SI	Suicidal Ideation
SIS	Suicide Intent Scale
SUAS	Suicide Assessment Scale
WHO	World Health Organization



# 1 INTRODUCTION

“Ah. I wondered when you would call.”

On opening the medical record to re-schedule an appointment, I was met by the strange sound and red sign that accompanies the word “Deceased”. Much saddened by this message, but not surprised, I called the closest relative of the patient, who greeted me with the above line and told me what had happened a fortnight before. The patient, a young person with a psychotic disorder, had died by suicide during the initial days of relapse. There had been suicide attempts before, all during psychotic episodes. The patient and I had discussed this about ten months earlier, when my patient had decided to quit medication – we agreed that the risk of suicide would be high in case of a new psychotic episode. We did not agree on the risk of relapse. Having made accurate predictions in both cases brought me no satisfaction, just a feeling of deep sorrow.

I entered this doctoral project as a clinician with experience of a so called high-risk group in terms of suicide: persons with first episode psychosis. This is not a large group and I have the privilege of being able to follow my patients closely. The descriptions of suicidality they had shared with me had left me with the impression that suicide risk was inherently difficult to assess and above all to manage: many told of suicidal ideation that came upon them as the psychotic symptoms worsened, sometimes escalating within hours or just minutes, driving them to severe suicide attempts. There seemed to be limited possibilities of detection or intervention if the process was so fast. But maybe suicide risk assessment was more feasible in other clinical settings, and maybe the standardised instruments I knew existed but rarely found use for were much more helpful in other patient groups? With this admittedly somewhat sceptical attitude, I started out.

## 1.1 TERMINOLOGY

“Comme le mot de suicide revient sans cesse dans le cours de la conversation, on pourrait croire que le sens en est connu de tout le monde et qu'il est superflu de le définir.”

*Émile Durkheim, 1897 (1)*

Many attempts have been made to suggest a common terminology in the field of suicide research (2-6) but at present, parallel definition systems exist. The World Health Organization (WHO) defines suicide as “the act of deliberately killing oneself” and suicide attempt as “...intentional self-inflicted poisoning, injury or self-harm which *may or may not have a fatal intent* or outcome” [emphasis added](7). They recognise the complications that may arise from including events without suicidal intent, but since suicidal intent can be “surrounded by ambivalence and even concealment” find it the most suitable definition for their purposes. The Centers for Disease Control and Prevention (CDC, a branch of the US Department of Health and Human Services) has a definition of suicide that resembles that of the WHO: “death caused by self-directed injurious behavior with an intent to die as a result of the behavior” but a more narrow definition of suicide attempt: “a non-fatal, self-directed,

potentially injurious behavior *with an intent to die* as a result of the behavior; might not result in injury” [emphasis added](8). The International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) provides standardised diagnostic codes for intentional self-harm (X60–X84) and poisonings and other events of undetermined intent (X40–X49, Y10–Y34) which can be used for both fatal and non-fatal acts. The intent here refers to the act of self-harm being intentional rather than unintentional, i.e. an accident. An intent to die as a result of an act cannot be derived from the ICD-10 codes alone.

It is difficult to assess the intent of someone’s actions, and for this reason many prefer the term self-harm for all self-injurious behaviours – a definition found in the guidelines of the British National Institute of Health and Care Excellence, NICE (9) and used by many European researchers in the field.

Others, among them many US researchers, find the distinction between acts with and without suicidal intent important to maintain, and so differentiate between suicide attempt and non-suicidal self-injury, NSSI. The latter term unfortunately has at least two definitions, one which only includes injuries to the skin (by cutting, burning, biting etc.) (10), and one which includes self-injury with any kind of method (11). Since 2012, the Food and Drug Administration (FDA, another branch of the US Department of Health and Human Services) demands that suicide-related adverse events in clinical trials are classified according to a specific set of criteria, the Columbia Classification Algorithm of Suicide Assessment (C-CASA) (6, 12). This has led to a widespread use of the corresponding interview instrument, the Columbia-Suicide Severity Rating Scale (C-SSRS) (13). This instrument defines an actual suicide attempt as a potentially self-injurious act committed with at least some wish to die as a result of act (i.e. very similar to the CDC definition). It also adds two new categories: aborted and interrupted suicide attempt, to define situations where a person “begins to take steps toward making a suicide attempt” but either stops wilfully or is interrupted by someone else. Non-suicidal self-injury is also assessed by the C-SSRS, defined as intentional self-injurious behaviour, regardless of method, with no intent to die as a result. It remains to be seen if this terminology will permeate future suicide research, but considering the criticism (14) and competing instruments (15, 16) it seems unlikely to happen in the near future.

The terms suicidal ideation (SI) and suicidal behaviour (SB) are often seen, sometimes combined as suicidal ideation and behaviour (SIB). Suicidal ideation usually means thoughts about wanting to be dead, thinking one would be better off dead, wanting to die by suicide or having plans for a suicide attempt. Suicidal behaviour is loosely if at all defined and can be used for suicide attempts, having made preparations for a suicide attempt, self-harming without suicidal intent and preparing for but not following through with a suicide attempt. Unless otherwise specified, suicide attempt is used in the following text when there is evidence of some intent to die as a result of the act. Non-suicidal self-injury is used when there is evidence that death was not intended, and self-harm is used for acts with and without intent to die.

## 1.2 EPIDEMIOLOGY

### 1.2.1 Global estimates

#### 1.2.1.1 Suicide

Suicide is a rare event accompanied by tremendous grief in those bereaved, and a strong desire to understand, explain and prevent it from ever happening again. It is estimated that for every suicide, five immediate family members are affected (17). The World Health Organization (WHO) estimated that almost 800,000 persons died by suicide in 2016 which translates into an annual global age-standardised suicide rate of 10.5 suicides/100,000 persons and year (18). A recent review of suicide mortality found that this rate decreased with 32.7% between 1990 and 2016 (19). This reflects the substantial reduction in suicide rates in China and India, which (at least in China) has been attributed to an improved socio-economic situation. Denmark has also had a marked reduction in suicide rate (60%). Further, it was noted that the decline in global suicide rates during this period was more pronounced in women (49%) than men (24%). In the US however, rates have increased by 1.5% per year since 2000, with regional differences where some states have seen an increase in suicide rate >30% for the period 2000–2016 (20).

There are large variations among countries with some of the highest suicide rates in men observed in Russia, Lithuania and Guyana (48.3, 47.5 and 46.6/100,000) with a male-to-female ratio of 3–7:1 (18). The highest suicide rates for women are seen in Lesotho, Uganda and Liberia (35.4, 18.7 and 17/100,000) with a female-to-male ratio of 0.8–1.4:1. The lowest rates reported are zero, which is interpreted as underreporting due to either lack of reliable mortality statistics and/or the fact that in some countries, suicide is highly stigmatized and in some places even illegal. Apart from stigma and legal issues, there are differences among countries regarding routines for cause of death certification, which also could affect the suicide rate (21).

Estimates of differences between regions from 2012 indicate that the suicide rate is similar in high and low income regions (12.7 and 13.4/100,000) with lower reported rates in upper-middle income countries (7.4/100,000) (7). The gender difference seen in high income countries, where the male-to-female ratio is 3.5:1, is not seen in other regions where ratios of 1.3–1.9:1 are reported.

In a review of psychological autopsies (interview studies with next-of-kin to suicide decedents, where information not present in e.g. registers can be obtained), medical record reviews and other study types, Luoma and co-workers found that on average, 19% of suicide decedents had been in contact with a mental health provider within a month of their suicide, and 45% had seen a primary care provider during the same period (not necessarily for mental health issues) (22). Corresponding figures for contact within a year of suicide were 24% for a mental health contact and 62% for primary care.

### *1.2.1.2 Non-fatal self-harm and suicidal ideation*

The annual rate of non-fatal self-injurious behaviours is more difficult to assess. This is due both to the varying definitions in use (which may or may not correspond to e.g. diagnoses in registers) but also to the fact that these events are not registered in the same way as suicide. Hospital records and registers can be used, but these can only give information about persons who have contact with the health care system in conjunction with a self-harm event. Help-seeking after self-harm has been assessed in mainly adolescent and young adult samples, indicating that less than 50% of those who self-harm seek professional help (23).

Based on mental health surveys conducted in different countries and regions, the WHO estimates a global annual rate of suicide attempt (which, by their definition, includes events without suicidal intent) of 4/1,000 in adults (>18 years) (7). A cross-national survey study based on almost 85,000 individuals in 17 countries in Africa, the Americas, Asia and the Pacific, Europe and the Middle East suggested that the lifetime prevalence of suicidal ideation and suicide attempts was 9.2% and 2.7% (24). The same study reported that about a third of those with suicidal ideation will make a suicide attempt, and that more than 60% of these transitions from thoughts to attempt will occur within the first year of ideation onset. A European survey study based on ca 25,000 persons reported an adult lifetime prevalence of suicidal ideation and suicide attempts of 7.8% and 1.3% (25).

In an English survey from 2014, separating suicide attempts and self-harm without suicidal intent, lifetime prevalence of suicide attempt was 6.7%. Self-harm without suicidal intent was reported by 7.3%, and 20.6% had had suicidal thoughts (26). In another recent survey of 18–34 year old persons in the UK, 11% reported having made a suicide attempt and 16% reported a previous non-suicidal self-harm, 3% and 5% within the past year. Almost 25% reported suicidal ideation at some point in life (27).

### *1.2.1.3 Non-fatal and fatal repetition*

In two systematic reviews, covering the literature from 1970 to 2012, the median incidence of non-fatal repetition of self-harm was 16% at one year and about 22–23% at 5 years (28, 29). Cohorts with above-median proportion of persons with more than one previous self-harm event had a one year repetition rate of 19%, significantly higher than cohorts with a larger proportion of first-time self-harm where the repetition rate was 15% (29). Cohorts in which repetition was identified by hospital attendance had a repetition rate of 17%. If repetition was identified only by hospital admittance, repetition rate was 13%, and if self-report by patients was used, repetition rate was 22% at one year (29). In one study evaluating time to non-fatal repetition in a sample of hospital-presenting persons with self-harm, the median time to repetition was 12 weeks (30).

The median incidence of suicide at one year after self-harm was 1.6–1.8%. The one-year estimate for men was 2.7% compared to 1.2% in women. Cohorts with an above-median age had a one year repetition rate of 2.4% compared to 1.1% in younger cohorts. Suicide risk persisted over time with a median incidence of 4.2% at 10 years (29) and 6.7% after 9 years (28).

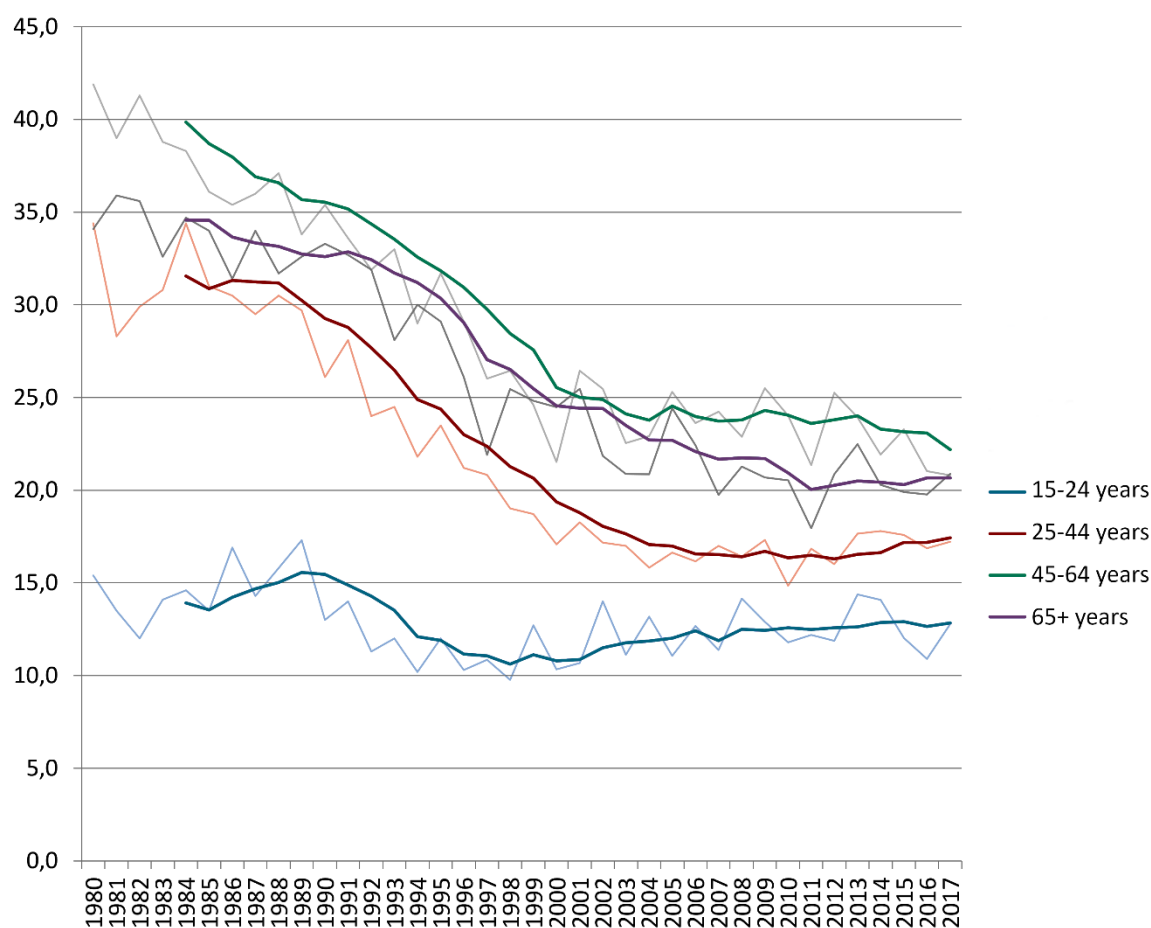


#### *1.2.1.4 Gender differences*

A consistent finding in official statistics and scientific studies is that non-fatal self-harm is more common in women whereas suicide is more common in men. This has been explored in a large amount of studies and among the proposed explanations are differences in help-seeking (31) and help-accepting behaviour and openness to consideration of the advice of others (32), cultural norms regarding acceptable behaviour (33), suicidal intent (34-37), and method choice (38). In a systematic review on risk factors for non-fatal repetition of self-harm, 68 studies exploring the effect of gender were found, with contradictory evidence as to if or how gender affects the risk of repetition (39).

#### **1.2.2 Swedish statistics**

At the end of 2016, 9.99 million persons lived in Sweden (40). During 2017, 1,189 (0.01%) of them died by suicide (ICD-10 codes X60–X84) (41). The majority, 70%, of all suicide deaths occurred in men, and men had higher suicide rates in all age categories compared to women except in ages 10–14 where the absolute numbers are very small and a single case has a large impact on the rate. Suicide is the most common cause of death in women aged 15–29 with 70 suicides in 2017, compared to 156 suicides in men the same age, who more commonly die in accidents. The age-standardized suicide rate for the Swedish population in 2017 was 11.8/100,000 (41). This rate has decreased since the 1980s, to the largest extent in older men who despite this still have the highest suicide rates. In some presentations on suicide statistics, deaths caused by poisoning and events of undetermined intent (ICD-10 codes X40–X49 and Y10–Y34) are included, for instance in statistics from the National Centre for Suicide Research and Prevention of Mental Ill-Health (NASP). According to their web page, this is based on studies indicating that as many as 70% of the events of undetermined intent probably are suicides (42). However, a recent study on suicide statistics in the Scandinavian countries found that in Sweden, 80% of the suicides were correctly classified while only 20% of the events of undetermined intent should be reclassified as suicides, with little impact on the overall suicide rate (43). In 2017, 355 persons died in an event of undetermined intent (41). Trends over time are presented in Figure 1, where moving means of the suicide rate have been used to smooth out short-term trends.



**Figure 1.** Moving means superimposed on annual suicide rates/100,000 persons and year in different age groups in Sweden during 1980–2017. From <https://ki.se/nasp/statistik>.

In 2017, 6,800 persons were admitted to Swedish hospitals with a diagnosis of intentional self-harm, 1,365 (20%) of whom were women aged between 15 and 24 years (44). Hospital admission with intentional self-harm is more common in women than in men in all age groups. For both men and women the rate of hospital admission after self-harm has declined somewhat during the last years, which could be due to changes in clinical management routines, shifting from inpatient to outpatient treatment (44).

The Public Health Agency Sweden (Folkhälsomyndigheten) issues a health survey every second year since 2004. In 2016, 13% of the respondents reported that they had experienced suicidal ideation at some point during their lives, and of these, 3% reported suicidal ideation during the past year (45). Almost 25% of female and 20% of male respondents aged 16–29 years reported life-time ideation compared to 6% of respondents aged 65–84 years. Regarding suicide attempt, 4% of the women and 3% of the men reported having made a suicide attempt at some point during their lives. Of those with life-time suicidal ideation, 28% had made a suicide attempt.

### 1.3 CORRELATES AND RISK FACTORS OF SUICIDE ATTEMPT AND SUICIDE

Many factors are described as risk factors for suicide and suicide attempt. The term itself deserves some attention. In 1997, Kraemer and co-workers described a risk factor typology according to which a *correlate* is a factor associated with another factor, but where it is not known how and why the factors are correlated (46). A *risk factor* is a correlate that is present before an outcome of interest. A risk factor that cannot be manipulated (like year of birth) is a *fixed marker*. A risk factor that can change or be changed (like age or weight) is called a *variable risk factor* – which could turn out to be a *causal risk factor* if 1: it can be manipulated and 2: the probability of the outcome systematically changes when the variable risk factor is manipulated. Using this typology, there is a large body of research on correlates and risk factors for suicide attempt and suicide (47).

Another general aspect of risk factor research is how the amount of exposure to a specific risk factor is evaluated. The exposure can be characterised in different ways (age at first exposure, total amount of time under exposure, largest dose, current dose etc.) and if the correct measure is not chosen, a correlation between a risk factor and a negative outcome may not be detected (48).

#### 1.3.1 Biological markers

Different biological factors have been studied as potential biomarkers or risk factors of suicide attempt and suicide – cholesterol, glucose, 5-hydroxyindoleacetic acid levels in cerebrospinal fluid, oxytocin, different cytokines, genes for e.g. the serotonin transporter, different nutrients – many however in cross-sectional studies with limited capacity for finding causal relationships. In a meta-analysis of longitudinal studies on biological factors (85 proposed risk factors, 9 proposed protective factors), the weighted mean odds ratio of all proposed risk factors was 1.41 for suicide attempt and 1.28 for suicide, none remaining significant after accounting for publication bias (49). Two single factors (with only one study each) remained significantly associated with suicide: one cytokine; vascular endothelial growth factor (50) and low levels of fish oil nutrients (51).

#### 1.3.2 Experience of interpersonal violence

A recent meta-analysis and systematic review on the effect of childhood maltreatment on adult suicidality showed that all types of abuse (emotional, physical and sexual) increased the risk of both suicidal ideation and suicide attempts by 2–3 times (52). There is also evidence that intimate partner abuse in adulthood increases the risk of suicide attempt (53). Verbal aggression, hostility, easily evoked anger and use of physical violence have all been shown to correlate with both suicide attempt and suicide in longitudinal studies (54). Bullying has also been studied, and being both a victim and a perpetrator is associated with increased risk of suicidal ideation and behaviour (55).

### 1.3.3 Psychiatric and other disorders

It is estimated from psychological autopsies from mainly Western European and US samples that a psychiatric disorder is present in 90% of suicide cases (56). Affective disorders are the most common in suicide decedents, followed by substance use disorder and schizophrenia (56). Almost every psychiatric disorder is associated with an increased risk of suicide (57, 58). Substance use disorders (particularly relating to opioids), anorexia nervosa and borderline personality disorder are among the conditions with the highest increase in lifetime risk.

Further, psychiatric inpatient care regardless of diagnosis as well as recent admission and discharge have all been correlated with an increased risk of suicide (57, 59-61). There is an ongoing debate on whether this is merely a consequence of selection bias, that the admitted patients are the most severely ill ones, or if the experience of hospital treatment in itself contributes to the increased risk (62).

The impact of psychiatric disorder and gender on the risk of suicide after self-harm has also been explored. In a large Swedish register study on patients admitted to hospital after self-harm in 1973–1982, with a follow-up time of 21 to 31 years, the male one-year incidence of suicide was 23% in bipolar and unipolar disorder, 22% in schizophrenia and 8% in anxiety disorders (63). Corresponding figures for women were 8.5%, 13% and 3%. Hazard ratios (HR) for the entire follow-up period ranged from 1.5 (anxiety disorder in women) to 4.1 (schizophrenia in men). Similar risks were found for a more recent cohort admitted after self-harm in 2000–2005 (64).

The influence of method of self-harm according to gender and diagnosis has also been studied in the hospital-treated cohort from 1973–1982. The male and female one-year incidence of suicide after a hanging attempt was 47% and 48% (65). About one quarter of men who used violent self-harm methods (drowning, shooting or jumping) died by suicide within one year. The corresponding figures for poisoning or cutting was 3–4%.

Corresponding figures for suicide incidence in women were 34% during the year after a drowning attempt and 15% after jumping from height, compared to 2–3% for poisoning and cutting. When psychiatric diagnosis was added, the one-year suicide incidence after a hanging attempt was 69% in men and women with a psychotic disorder (e.g. schizophrenia), and about 50% in men and women with an affective (bipolar and unipolar) disorder (65).

Method at non-fatal self-harm and subsequent risk of suicide has also been studied in a cohort of children and young adults (10–24 years) who were treated after self-harm in specialist (non-psychiatric) health care between 2000 and 2009. The suicide risk was increased in those who were admitted to hospital care after self-harm with a violent method, and this was also observed for young women hospitalised after self-harm by cutting (66).

Many somatic disorders, e.g. neurological conditions such as Huntington's disease and multiple sclerosis, different types of cancer, pulmonary disease, HIV/AIDS and stroke have been shown to increase the risk of suicide, highlighting the need for suicide risk management in primary and specialised somatic care settings (67, 68).

### **1.3.4 Symptoms and cognitive features**

Apart from diagnoses, specific symptoms or cognitive features have been studied in relation to suicide attempt and suicide. Hopelessness has been shown a stronger correlate of suicidal ideation, suicide attempt and suicide than a diagnosis of depression in various clinical samples of suicide attempters (69, 70). In a retrospective study of the medical charts of inpatient suicides, 79% had signs of severe anxiety or agitation in the week before the suicide, however no controls were included in this study (71). In a meta-analysis of controlled studies, anxiety and agitation were correlated to in-patient suicide with an OR of 2.13 (72). Cognitive rigidity and poor problem solving has also been associated with suicidal ideation and behaviour (73), as well as perfectionism (74, 75), rumination (76-78) and cognitive and behavioural impulsivity (79). Insomnia and nightmares were highly prevalent in a sample of suicide attempters (80). Sleep disturbances in general have been correlated with an increased suicide risk (81) as has chronic pain (82).

The problem with reliance on self-report regarding e.g. suicidal ideation has been identified, and attempts have been made to assess suicidality without asking about it explicitly. The Implicit Association Test (which evaluates thoughts and feelings that are largely outside of conscious awareness and control) has been modified to test the association between self and death/suicide (83). In a study on suicide attempters, it was shown that a strong implicit association of death with self was associated with increased risk of a reattempt within six month.

### **1.3.5 Interpersonal problems**

Interpersonal conflicts have been found to increase the risk of both initiation and repetition of self-harm (55, 84, 85) and lower perceived peer support is more prevalent in young adults who self-harm (86). In a sample of almost 25,000 adult, hospital-treated self-harm patients, relationship problems were identified as the most common life problem in connection with the self-harm event (87). Interpersonal problems but also increased loneliness, social isolation and perceived loss of control were found to be correlated to suicide attempt in a systematic review on risk factors in older adults (all aged 60 years and above) (88).

### **1.3.6 Previous self-harm**

Previous self-harm is often described as a major risk factor for both repetition of self-harm and suicide (28-30, 89-92). In a systematic review of psychological autopsy studies, it was estimated that at least 40% of those who die by suicide have a history of self-harm (56). When the prognosis after non-fatal self-harm is studied prospectively, 1–6% die by suicide during the first year, suggesting an increased suicide risk of 50–100 times compared to the general population (28, 93).

### **1.3.7 Specific risk factors for repetition?**

Apart from previous self-harm, which for obvious reasons cannot be a risk factor for a first-time self-harm event, there is no convincing evidence of risk factors unique to repetition

of self-harm. The factors most consistently correlated to non-fatal repetition are previous self-harm, having a psychiatric disorder (including substance use), being in psychiatric treatment and being a victim of sexual abuse (39, 94). Risk factors for fatal repetition includes older age, previous self-harm, suicidal ideation, living alone, being male and having a substance use disorder.

## 1.4 UNDERSTANDING SUICIDE

In early philosophical and religious traditions, from the ancient Greek and through Judaeo-Christian and Muslim thinking, suicide was often (and still is, in some communities) considered a crime and/or a sin. It could be seen as taking a liberty one did not have since one's life belonged to one or many gods (both Plato and St Thomas Aquinas expressed this view) (95) and being desperate enough to attempt suicide could also be seen as an almost heretic lack of trust in divine mercy. Some pointed out that the delicate balance of the universe would be disturbed if a soul or a person suddenly disappeared (the Pythagoreans as well as later thinkers proposed this) (95, 96). Early suicide preventive strategies included stigmatization, punishment of persons attempting suicide, degrading the remains of persons who had died by suicide and maltreatment of those bereaved (95). Parallel to this, an understanding could be expressed for suicides in certain situations, such as being sentenced to death by suicide (which condoned the suicide of Socrates) but there is also evidence that extreme personal circumstances that could have included severe mental disorders could invoke a less repressive response (95, 97). In the late 1700s, suicide began to be conceptualised as a sign of mental disorders, at least in parts of Western societies, and the idea of suicide as a crime was challenged.

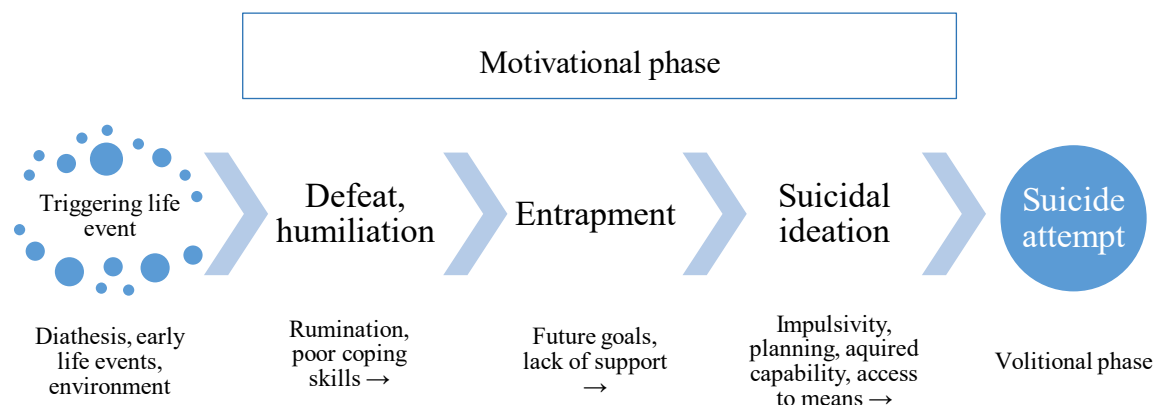
In 1897 Durkheim considered the phenomenon from a sociological point of view. He defined suicide as all deaths where death was chosen over life, i.e. also soldiers in war, martyrs, sacrificing one's life for something or someone else. He identified four suicide types based on aspects of social integration (to what extent a person has ties to a social group) and regulation (normative and moral demands of the group, which must be met by its members) but rejected the idea that all suicides were caused by psychiatric disorders (1, 98).

In more recent decades, several models have been presented. Most of them describe suicidal behaviour as a result of an interaction between predisposing and precipitating factors with different emphasis on how the transition from ideation to action comes about (99). Many of them have a high face validity in explaining suicide, and some of them are researched for empirical evidence, but there has been little if any comparative research into which model is the most accurate (47). It should be noted that they are mostly conceptual models aimed at understanding suicidal behaviour, not mathematical models aiming at predicting it, so it follows that comparison will be difficult. Here, some of them are described.

Shneidman described suicide as a result of *psychache*, an intolerable psychological pain that cannot be dealt with. While the individual may not necessarily wish to die, suicide seems like the only solution (100). Schotte described a *diathesis-stress-hopelessness model* emphasising cognitive rigidity and poor problem solving skills as factors associated with suicide risk (101) and a variant of this model has also been described by Mann (102).

The *interpersonal-psychological theory* states that a suicide can only occur if there is both desire to die by suicide (which stems from a perception of being disconnected, no longer belonging in the company of others, and being a burden to them) and a capability to act on that desire (103). The capability consists of two dimensions, lowered fear of death and increased tolerance to physical pain and is, according to this theory, acquired by repeated exposure to painful and provocative events, e.g. interpersonal violence, combat exposure and previous suicide attempt. Many studies have been published on this theory, including some questioning its claims (104, 105).

Michel and members of the Aeschi Working Group emphasise the importance of exploring the intersubjective meaning of the suicide attempt, i.e. an act needed to be understood in the context in which it developed rather than a symptom of a psychiatric disorder (106). This model has direct implications for treatment, focusing on the patient's detailed narrative of the circumstances of a suicide attempt, and the development of an individual safety strategy. Another model, which attempts to combine components from previous models into one, is the *integrated motivational-volitional model*, which is presented in Figure 2 (107). It includes “moderators”, factors that affect the likelihood of transition from phase to phase.



**Figure 2.** The integrated motivational-volitional model, adapted from O'Connor.

Difficulties in problem-solving, poor coping skills and rumination are described as “threat-to-self” moderators, contributing to feelings of entrapment. Motivational moderators, e.g. perceptions of the future and social support (or lack thereof) give way to suicidal ideation, but for the transition from ideation to action to occur, some volitional moderator such as acquired capability, impulsivity or planning and access to support must be present.

## 1.5 STANDARDISED INSTRUMENTS USED IN SUICIDE RISK ASSESSMENT

One of the first suicide risk assessment tools was constructed in 1963 by the Los Angeles Suicide Prevention Center, to be used to evaluate risk in persons calling the centre. An

instrument proposed for clinical settings was presented in 1968 (108) and since then, many have followed. Examples include the Suicide Intent Scale and the Suicide Assessment Scale (both described in more detail in the Method section) (109, 110), the Beck Scale for Suicide Ideation (111), the SAD PERSONS scale (112), the Manchester Self-Harm Rule (113) and the ReACT self-harm rule (114). They are similar in the overarching structure of being mainly characteristics of the person under assessment, correlated to suicide attempt or suicide. Some are checklists assessing the presence or absence of specified thoughts, feelings, behaviours and/or outer circumstances whereas some add a range to the factors in terms of proposed severity. A total score is yielded by addition of item scores. Clinician- or system-related risk factors, such as clinician fatigue or lack of hospital beds or skilled psychotherapists, are rarely assessed (115).

Other instruments not specifically focused on suicide have also been used in suicide prediction studies, for instance the Beck Depression Inventory (rating severity of depression) (116) and the Beck Hopelessness Scale (rating hopelessness and pessimism) (117).

Some instruments use weighting of the items and take interaction effects into account. One example is Motto's risk estimator for suicide, using 15 variables including the interviewer's reaction to the patient to give a two-year risk of suicide (118). A very recent publication presents the derivation and validation of an algorithm using a Swedish cohort of patients with schizophrenia and bipolar disorder, giving an estimated one-year risk of suicide (119). A suicide risk calculator based on this study is available online (120).

### **1.5.1 Responding and reacting to questions about suicidality**

Even though a standardised interview instrument gives a more structured output than the clinical interview, both rely on patient self-report, the quality of which depends on the patient's honesty, introspective capacity, ability to understand the questions and to recall details on thoughts and feelings from weeks ago. All these can be affected for various reasons including ongoing symptoms that colour the memory of previous experiences, impaired episodic memory, not wanting to disclose specific issues or wanting to emphasise others. If a self-rated instrument is used one also has to acknowledge different ratings styles that might be associated with personality traits, such as being an extreme responder, or always choosing an alternative close to the median.

Regarding self-reported suicidality, one study on a sample of undergraduate students with a life-time history of suicidal ideation found that disclosure was most accurate to mental health professionals, and least accurate to family members (121). Barriers to disclosure were fear of worrying family members, fear of being hospitalised and fear of experiencing embarrassment during therapy. An expression of empathy was however the most common response from both professional caregivers and family members. In a qualitative study on men aged 60 and above with an ongoing or recent depressive episode, 98% expressed a positive attitude to discussing suicidal ideation with their general practitioner (122). A positive attitude to suicide screening was also found in a sample of medical emergency seeking patients (123). More hesitant attitudes were observed in a study involving US Army veterans (124). Feelings of



inadequacy and shame associated with suicidal ideation were identified as barriers to disclosure, as was uncertainty about confidentiality. The genuineness, empathy and straightforwardness of the health care professional were cited as vital to disclosure. In a large Dutch population survey study, suicidal ideation disclosure was associated with poor health including psychological distress and frequent suicidal ideation (125). Being male, of older age, having a lower education level and poor social connectedness were factors associated with increased odds of non-disclosure of suicidal ideation in a large French mental health survey (126). Several studies have explored the impact of asking about suicidal ideation and behaviours and there is of yet no evidence that this initiates or increases suicidal ideation (127-131).



## 2 AIMS

The aim of this thesis was to evaluate the ability of different assessment instruments to predict suicide attempt and suicide in a psychiatric cohort within up to one year after an event of self-harm with or without suicidal intent, to study if it were possible, in a clinically meaningful way, to identify those with the highest risk within this high-risk group. The research questions of the specific studies were:

Study I: Is experience of interpersonal violence, assessed with the Karolinska Interpersonal Violence Scale (KIVS), associated with an increased risk of non-fatal or fatal suicide attempt within six months of a suicide attempt? If so, to what extent?

Study II: Can the characteristics of suicidal ideation and behaviour, measured with the Columbia-Suicide Severity Rating Scale, (C-SSRS) predict non-fatal or fatal suicide attempt within six months of a self-harm event? If so, to what extent?

Study III: Are there any differences in the predictive abilities of the Suicide Intent Scale (SIS), the Suicide Assessment Scale (SUAS), KIVS and C-SSRS in predicting suicide attempt and suicide within three months and a year? If so, are any of these instruments clinically useful for this purpose?

Study IV: How does a clinical suicide risk assessment compare to the well-established SIS in predicting suicide during a follow-up time of one year after a self-harm event? Is predictive accuracy increased if these assessments are combined?



### 3 MATERIAL AND METHODS

	Study I	Study II	Study III	Study IV
<b>Research focus</b>	Interpersonal violence as predictor of suicide attempt	Suicidal ideation and behaviour as predictor of suicide attempt	Comparison of predictive accuracy of assessment scales	Clinical suicide risk assessment vs Suicide Intent Scale
<b>Study design</b>	Cohort study	Cohort study	Cohort study	Cohort study
<b>Study population</b>	Individuals with suicide attempt in a Swedish multi-centre study, 2012–2014.	Individuals with self-harm with or without suicidal intent in a Swedish multi-centre study, 2012–2016.	Individuals with self-harm with or without suicidal intent in a Swedish multi-centre study, 2012–2016.	Individuals with self-harm with or without suicidal intent, Stockholm subset, 2012–2016.
<b>Size of study population</b>	355	804	804	479
<b>Data source</b>	Research interview and medical records	Research interview and medical records	Research interview, medical records and Cause of Death register	Research interview, medical records and Cause of Death register
<b>Follow-up time</b>	Six months	Six months	Three months, one year	One year
<b>Predictor/s</b>	KIVS score	C-SSRS total score, C-SSRS subscale scores	Total scores of SIS, SUAS, KIVS and C-SSRS	SIS score and clinical risk assessment score
<b>Outcome</b>	Composite outcome: Non-fatal and fatal suicide attempt	Composite outcome: Non-fatal and fatal suicide attempt	Suicide attempt, suicide	Suicide
<b>Statistical analyses</b>	$\chi^2$ -test, t-test, logistic regression, ROC curves	Logistic regression, ROC curves	$\chi^2$ -test, Mann-Whitney U-test, ROC curves	$\chi^2$ -test, logistic regression, ROC curves

**Table 1.** Summary of the studies

KIVS=Karolinska Interpersonal Violence Scale. C-SSRS=Columbia-Suicide Severity Rating Scale. SIS=Suicide Intent Scale. SUAS=Suicide Assessment Scale. ROC=Receiver Operating Characteristics.

### **3.1 COHORT STUDIES**

All studies in the present project are prospective, observational cohort studies: longitudinal studies aiming to assess the impact of one or more specified factors on an outcome of interest. A cohort is a group of people sharing some defining feature or experience who are observed for a period of time, to see what happens to them. Data can be collected actively from the members of the cohort at specific time points, or collected from medical records or registers without their active participation (or knowledge), or both, as in the present project. Among the data collected are variables that are hypothesised or known to influence the probability of an outcome of interest; exposure and control variables. The members of the cohort should be free of the outcome of interest at the start of the study, and in an observational study, no treatment or exposure is given to them as part of the study. The follow-up time should be sufficiently long, given what is known about the natural course of the condition studied and the incidence of the outcome observed. The incidence of the outcome in the cohort can be compared to that of the general population (from which the cohort was drawn). Alternatively, sub-groups within the cohort can be compared to each other. Absolute and relative risks can be calculated. The impact of an exposure on the incidence of the outcome can be assessed with regression analyses to enable adjustment for other factors known to influence the incidence.

### **3.2 DATA COLLECTION**

#### **3.2.1 The multicentre study**

This doctoral project is based on a clinical multicentre study conducted in Stockholm, Gothenburg and Umeå with inclusion on all three sites between April, 2012 and April, 2016. Patients seeking or being referred for a psychiatric evaluation after an event of self-harm with or without suicidal intent were considered for inclusion. To enable follow-up through medical records and national registers, participants had to be residents of the catchment area of the respective sites and have a Swedish personal identity number. Patients with symptoms or behaviours interfering with verbal communication (cognitive impairment, psychosis, intoxication, aggressiveness) were not considered for inclusion, but a diagnosis of e.g. a psychotic disorder was not an exclusion criterion. If the patient was unable to take part in the research interview at first arrival to the psychiatric clinic but stayed as an inpatient, they could be eligible for participation when the interfering symptoms had resolved. The majority of interviews were performed within seven days of the self-harm event.

The three sites represent somewhat different clinical settings. In Stockholm, the psychiatric emergency department situated at St Goran's Hospital serves all of Stockholm County with 2.2 million inhabitants. Many patients are assessed there and then transferred within 24 hours to one of the psychiatric clinics in Stockholm. One of these, Northern Stockholm Psychiatry (Norra Stockholms psykiatri), is administratively connected to the emergency department and located on the same premises. Patients belonging to this clinic could also be included if they, as inpatients, had had an event of self-harm.

In Gothenburg, study participants were identified via a psychiatric consultation team connected to the somatic emergency department and wards at Sahlgrenska University Hospital. This hospital has a catchment area of ca 400,000 inhabitants. Patients presenting directly to the psychiatric emergency department at Östra Hospital after self-harm were not available for inclusion.

In Umeå, the psychiatric emergency department and clinic is the only provider of psychiatric inpatient care serving a catchment area of 150,000 inhabitants. Potential study participants were identified in the emergency department or at the wards.

### **3.2.2 Baseline data**

#### *3.2.2.1 The research interview*

The research interview was carried out by psychiatrists, a psychologist and psychiatric nurses. Those unexperienced with the instruments used were given special training and supervision. Twenty interviews were performed with parallel ratings for assessment of interrater reliability. The interview included questions about method at the index attempt, previous suicide attempts and/or non-suicidal self-injury, other health related (e.g. family history of or environmental exposure to suicide and suicide attempt, present somatic disorders, present or previous contact with psychiatric care) and socio-demographic (e.g. living conditions, highest attained educational level, present occupation) factors. Standardised instruments were also applied. The interview lasted about 1.5 hours.

#### *3.2.2.2 The Karolinska Interpersonal Violence Scale*

The Karolinska Interpersonal Violence Scale (KIVS) was originally presented in a study of 161 suicide attempters where it was shown that high scores predicted suicide (132). The scale has four items presented in Table 2, assessing the use of and exposure to violent behaviour in childhood (6–14 years) and as an adult ( $\geq 15$  years). It is based on a semi-structured interview and each item is scored 0–5 giving a range for the total score of 0–20 with higher scores indicating more severe forms of violence expressed or experienced. The first study showed high inter-rater reliability ( $r = 0.91–0.95$  for the separate items) and the KIVS has been validated against more extensive instruments assessing experience of violence such as the Buss-Durkee Hostility Inventory (133, 134). It has been used in studies assessing the interplay between experience of interpersonal violence, family history of suicide, substance use and suicidality (135–138).

Expression of violence, 6–14 years	Expression of violence, ≥15 years	Exposure to violence, 6–14 years	Exposure to violence, ≥15 years
1: Occasional fights 3: Often started fights 5: Caused serious injury	1: Occasionally slapped or shoved an adult 3: Assaulted partner 5: Caused severe bodily harm, death, repeated sexual assault	1: Occasionally slapped 3: Often bullied, hit by parent 5: Repeated exposure to violence or sexual abuse	1: Threatened or exposed to low-level violence once 3: Robbed, frequently beaten by partner 5: Repeatedly raped or battered, seriously injured

**Table 2.** The four items of the KIVS, with some examples.

### 3.2.2.3 The Columbia-Suicide Severity Rating Scale

The Columbia-Suicide Severity Rating Scale (C-SSRS) presented in Figure 3 evaluates suicidal ideation and self-harm behaviours (13). There are two subscales for ideation: severity and intensity. The ideation severity subscale ranges from wish to be dead to active suicidal ideation with specific plan and intent to act, similar to the “suicide ladder” questions based on Paykel’s observation of suicidal feelings occurring on a continuum (139). The ideation intensity subscale contains the items frequency, duration and controllability of the most severe thoughts. Factors deterring the person from acting are scored as well as reasons for ideation. Behaviours are classified as actual, interrupted or aborted suicide attempts, preparatory acts or non-suicidal self-injurious behaviour. Actual suicide attempts are classified according to actual or potential lethality or medical damage. The C-SSRS has been used in prediction studies in mainly adolescent and young adult populations (140-143) with one study specifically addressing the risk of repetition of self-harm (13). Since it is originally an instrument for classification there are no instructions on how to obtain a total score. One of its items is the sum of a subscale, and thus cannot be counted when summing the total score. Three other C-SSRS items (numbers of actual, aborted and interrupted suicide attempts) can take on a wide range of values. For the purpose of the current studies, this was addressed by trichotomising the numbers of actual, aborted and interrupted suicide attempts: 0 (no attempts), 1 (1-2 attempts) and 2 (three or more attempts) and these values were applied when calculating the total score. Using this approach the total score has a range of 0–42 (144).



Ideation severity	Ideation intensity	Behaviours, yes/no. Number of attempts scored for all kinds of suicide attempt
<ul style="list-style-type: none"> <li>•1: Wish to be dead</li> <li>•2: Thoughts of suicide</li> <li>•3: Thoughts of suicide with specific method, no intent to act</li> <li>•4: Thoughts of suicide, with specific method and some intent to act</li> <li>•5: Thoughts of suicide, specific method, plan and some intent</li> </ul>	<ul style="list-style-type: none"> <li>•Frequency, 1–5</li> <li>•Duration, 1–5</li> <li>•Controllability, 0–5 where 0=does not attempt to control thoughts</li> <li>•Deterrents, 0–5 where 0=does not apply</li> <li>•Reasons for ideation, 0–5 where 0=does not apply</li> </ul>	<ul style="list-style-type: none"> <li>•Actual suicide attempt,</li> <li>•Interrupted suicide attempt</li> <li>•Aborted suicide attempt</li> <li>•Preparatory acts</li> <li>•Non-suicidal self-injury</li> </ul> <p>•<b>Medical severity</b> of actual attempts is scored 0–5. If 0, potential severity is scored 0–2.</p>

**Figure 3.** The items assessed by the C-SSRS.

#### 3.2.2.4 The Suicide Assessment Scale

The Suicide Assessment Scale (SUAS) was constructed to measure symptoms relevant for suicidality independent of other diagnoses (110). It is supposed to be sensitive to change over time and evaluates both observed and reported symptoms (145). The 20 items presented in Table 3 are scored 0–4, yielding a potential range of 0–80. The items concerns five domains (affect, bodily states, control and coping, emotional reactivity and suicidal thoughts and behaviour). The inter-rater reliability from the original study was 0.78–0.88 and the criterion and concurrent validity was reported to be satisfactory [Stanley, B. et al, The suicide assessment scale, *Psychopharmacol Bull*, 1986 quoted in (145)]. There is also a Norwegian version with robust measures of internal consistency, test-retest reliability and concurrent validity (146).

Sadness, despondency	Resourcefulness	Impulsivity	Suicidal thoughts
Hostility	(difficulties in problem-solving)	Low self-esteem	Purpose of suicide
Lack of energy	Perceived loss of control	Hopelessness	Wish to die
Hypersensitivity	Physical tension	Inability to feel emotions	Lack of reason for living
Emotional withdrawal	Anxiety	Poor frustration tolerance	Suicidal actions
	Somatic concern		

**Table 3.** The 20 items assessed by the SUAS.

### 3.2.2.5 The Suicide Intent Scale

The Suicide Intent Scale (SIS) has 15 items and was constructed to reflect the degree of suicidal intent at a recent suicide attempt (109, 147). The items presented in Table 4 cover objective circumstances of the attempt and the person's expectations and beliefs about the attempt. Items are scored 0–2 and the total score has a range of 0–30. It has been widely researched: in a review from 2008, 13 studies on suicide prediction and 17 studies on prediction on non-fatal repetition were identified, with five studies showing positive correlations between high SIS scores and suicide (148). The findings for non-fatal repetition were mostly negative.

The objective items		The subjective items	
Isolation	Final acts in anticipation of death	Alleged purpose of attempt	Attitude toward living/dying
Timing	Active preparation for attempt	Expectation of fatality	Conception of medical reversibility
Precautions against discovery	Suicide note	Conception of lethality of method	Degree of premeditation
Acting to get help during/after attempt	Overt communication of suicidal intent	Seriousness of attempt	

**Table 4.** The 15 items assessed by the SIS.

### 3.2.2.6 The clinical risk assessment

Information about the clinical suicide risk assessment was extracted from medical records at the Stockholm site, where doctors are required to choose one of four fixed responses (minimal, moderate, high or very high suicide risk). According to the department's own guidelines doctors are encouraged to consider risk factors as well as protective factors, and to assess both long and short term risk. There are no explicit instructions on if/how the treatment planned in the short time perspective should be taken into consideration when recording the risk, and consequently, different approaches exist.

## 3.2.3 Outcome data

### 3.2.3.1 Medical records

The final clinical diagnosis made at the time of the index attempt was gathered at the follow-up evaluation.

Outcome events were identified by reading all available entries for the follow-up time in the medical record. All self-harm events described were recorded with date, method and type of

event: suicide attempt, non-suicidal self-injury or self-harm with unknown intent. Since the record systems are linked to the Population Register, all deaths during the follow-up period could also be registered, however not with a cause of death in all cases.

#### *3.2.3.2 Cause of Death Register*

The Swedish Cause of Death Register is held by the National Board of Health and Welfare (Socialstyrelsen). It contains data on all individuals who have died in Sweden and all deaths of Swedish residents, even if death occurred abroad. It is virtually complete regarding the number of deaths. A small proportion (<1%) lack an underlying cause of death (149). The cause of death for all participants deceased within a year of the index attempt was retrieved from this register.

### **3.3 STATISTICAL ANALYSES**

Descriptive statistics included calculation of total ranges, means and standard deviations, and medians and interquartile ranges.

Proportions were compared with Fisher's exact test and Pearson  $\chi^2$ -test.

Mann-Whitney U-test was used in study III for between-group comparison of distribution of ordinal variables.

Logistic regression was used in studies I–II and IV to assess the influence of continuous and non-continuous independent/explanatory variables on a binary dependent/outcome variable. Multiple explanatory variables can be analysed at the same time which allows for adjustment for potentially confounding factors. A logistic regression yields one odds ratio (OR) for each independent variable. The OR answers the question: if the independent variable is increased by one unit (e.g. a one-step increment on a rating scale), by how much does the odds of the outcome (e.g. suicide) increase or decrease, if the other independent variables are held constant?

The Cox & Snell's and Nagelkerke's  $R^2$  are presented as estimates of the proportion of variance in the outcome explained by the logistic regression model.

Receiver operating characteristics (ROC) curves were constructed in studies I–IV. The ROC curve is a graphical plot illustrating the diagnostic ability of a binary classifier system (e.g. high risk/low risk) as its detection threshold (e.g. chosen cut-off on a rating scale) is varied. It is created by plotting the true positive rate (see below) against the false positive rate at various threshold settings. The area under the curve (AUC) represents the probability that the test will correctly identify two randomly drawn subjects with and without the outcome of interest. An appropriate cut-off level can be determined from the ROC curve. One way is to choose the level that maximizes the sum of sensitivity and specificity, another is to choose a level that is appropriate in a certain context. This in turn depends on the outcome being predicted, and the measures taken based on the test result.

Accuracy statistics – sensitivity, specificity, positive and negative predictive value – were calculated in all studies.

	True condition positive	True condition negative	Total	
Test positive	a	b	a + b	<b>Positive predictive value:</b> $a/(a + b)$
Test negative	c	d	c + d	<b>Negative predictive value:</b> $d/(c + d)$
Total	a + c	b + d		
	<b>Sensitivity</b> $a/(a + c)$	False positive rate $b/(b + d)$		
	False negative rate $c/(a + c)$	<b>Specificity</b> $d/(b + d)$		

**Table 5.** A 2x2 table showing how to calculate the accuracy statistics measures.

**Sensitivity**, true positive rate: the proportion of subjects with the outcome correctly identified by the test.

**Specificity**, true negative rate: the proportion of subjects without the outcome correctly identified by the test.

**Positive predictive value:** the proportion of subjects with a positive test result that has the outcome. This is dependent on the prevalence of the outcome in the tested population, as is the **negative predictive value:** the proportion of subjects with a negative test result that do not have the outcome.

All tests were two-sided and p-values <0.05 were considered statistically significant. The p-value answers the question: if the null hypothesis were true, what is the chance of randomly getting the observed result, or a more extreme one? The null hypothesis is usually that there is no difference between the studied populations regarding the variables of interest (their distribution, correlation etc.).

Point estimates of AUCs, ORs, accuracy statistics etc. are presented with 95% confidence intervals. Provided that our data comes from individuals that were randomly selected from a larger population, there is a 95% probability that the interval will contain the point estimate of the population from which the individuals were drawn.

Rating scales were used to measure factors of presumed interest for the outcome. These measurement instruments can themselves be evaluated regarding reliability and validity. *Reliability* refers to the extent to which an instrument gives consistent measures in terms of its items measuring the same underlying construct (i.e. the internal consistency of a scale), the result being consistent over time (if the phenomenon measured is presumed to be stable) and between different users of the instrument. In this project, internal consistency was assessed with Cronbach's  $\alpha$ . It has a theoretical range of  $-\infty$  to one. Values very close to one indicate redundancy; that some items measure the same latent variable. Values below 0.5 indicate that more than one underlying construct might be captured by the scale. Interrater reliability was assessed with intra-class correlation for the total sums SIS, KIVS and SUAS and with prevalence-adjusted, bias-adjusted kappa (PABAK) for the C-SSRS items due to the uneven distribution of responses.

*Validity* refers to the degree to which a method measure what it claims to measure. The instruments evaluated in this project have previously been validated against other instruments, and no such evaluations were made with the present data.

### **3.4 ETHICAL CONSIDERATIONS**

Given the serious nature of self-harm, it is of importance to study the subject in order to provide a scientific basis for future interventions, with the overarching goal of helping those afflicted. This project is based on interviews with persons who have recently harmed themselves, which called for consideration in all parts of the process: identifying potential study participants, giving information about the study and asking for participation and administering the research interview. All interviewers collaborated with the regular staff members concerning which patients to ask, and when that was appropriate. All patients received verbal and written information about the aim and method of the study, the possibility to discontinue the interview and to withdraw consent. It was made clear that study participation would not affect the treatment. Participants were also informed that the research interview was subject to confidentiality unless information of urgent medical character transpired, in which case the regular staff would be briefed.

The interview questions concerned potentially sensitive issues with the possibility of triggering strong emotional response from persons already in a vulnerable situation. All interviewers had long experience in working with psychiatric patients, and effort was taken to create a calm interview setting both in terms of an emotionally safe environment and of avoiding external distractions.

The outcome events were identified via medical records. Since all text was read in order to find all mentions of self-harm events, it was inevitable that the persons doing the follow-up reading would be aware of a large amount of other data as well. No information apart from data on the specified outcomes was registered. In communicating results, it should be kept in mind that even though data are presented at group level, some of the groups are very small and refer to persons who are still alive or recently deceased, calling for utmost caution in presentation of detailed information.

### **3.4.1 Taking part in a study – comments from the participants**

During the planning stage of this study, some members of the hospital staff were concerned that the interview would be overly stressful for the participants. This was however not the impression of the interviewers – or the hospital staff, once the study was ongoing. Although many respondents found it disturbing to relate in detail what they were thinking and feeling prior to the self-harm event, most found the research interview a positive experience overall. “It was good to talk about it, I haven't described this in so much detail to anyone before”, as one of them put it. Many expressed a positive attitude to research being conducted on these issues and a hope that others would come to benefit from their participation.

### **3.4.2 Interviewing for a study – reflections from a clinician**

Having worked as a doctor for over two decades, I have had many kinds of meetings with patients, and I soon realized that the interviews in this project were special. Even though the setting was similar to clinical work, the rules were not: the interview was optional, participants could say no to begin with or end the interview if and when they wanted, as some did. Further, and most important, our meeting was not supposed to end with me deciding about something that might be of deep personal importance to the participants, such as being kept in hospital or being given – or denied – specific treatment. This situation did of course apply to the other interviewers as well and might have contributed to the calm atmosphere of many of the interviews. One could in turn speculate as to how this might have affected the participants' introspective abilities and motivation for considering the questions seriously, which could affect the external validity of our results.

## 4 RESULTS

Age, years	33 (23–50)†
Women	541 (67%)
Men	263 (33%)
Suicide attempt at index	666 (83%)
Non-suicidal self-injury at index	138 (17%)
Previous suicide attempt	544 (68%)
Previous non-suicidal self-injury	421 (53%)
Admitted to hospital bed at index	747 (93%)
<b>Current occupation</b>	
Work/student/retired	409 (51%)
Unemployed/sick leave/disability pension	395 (49%)
<b>Clinical diagnosis at index, any position</b>	
Anxiety disorder (F40–48)	320 (40%)
Mood disorder (F30–39)	295 (37%)
Personality disorder (F60)	170 (21%)
Substance use disorder (F10–19)	172 (21%)
Disturbance of activity and attention (F90.0)	83 (10%)
Autism spectrum disorder (F80–89)	54 (6.6%)
Psychotic disorder (F20–29)	26 (3%)

**Table 6:** Baseline characteristics of the sample (N=804) used in Study II and III.

†median (interquartile range).

All values except age are presented as N (%). Diagnoses are not mutually exclusive.

	<b>Study I</b>	<b>Study II</b>	<b>Study III</b>	<b>Study IV</b>
<b>N in cohort/in analysis</b>	452/355	804/794-802	804/746	479/422 – 457
<b>Follow-up time</b>	Six months	Six months	Three months, one year	One year
<b>Outcome N (%)</b>	Non-fatal and fatal suicide attempt 78 (22%)	Non-fatal and fatal suicide attempt 165 (20.5%)	<b>Three months</b> Suicide attempt 114 (14%) Suicide 5 (0.6%) <b>One year</b> Suicide attempt 216 (27%) Suicide 19 (2.4%)	Suicide 14 (2.9%)
<b>Instrument/s evaluated</b>	KIVS	C-SSRS	SIS, SUAS, KIVS and C-SSRS	SIS, clinical risk assessment
<b>Main finding</b>	KIVS total score $\geq 6$ is predicts suicide attempt within 6 months	SI intensity score predicts suicide attempt within 6 months	<b>SIS</b> score predicts suicide at 3 months and one year. <b>C-SSRS</b> score predicts suicide attempt at 3 months and one year. <b>SUAS &amp; KIVS</b> predicts suicide attempt at one year.	The AUC and accuracy statistics were very similar for the clinical assessment and SIS score.
<b>OR (95%CI)</b>	1.81 (1.08–3.02)	1.07† (1.03–1.1)	-	Clinician rated high risk 4.1 (1.2–13.4) SIS rated high risk 5.1 (1.5–16.8)
<b>ROC curve, AUC (95%CI)</b>	0.57 (Not reported)	0.62 (0.57–0.66)	SIS, suicide one year 0.74 (0.61 – 0.87)	Clinician 0.68 (0.53–0.82) SIS 0.72 (0.54–0.89)
<b>Accuracy statistics</b>	KIVS score $\geq 6$ Sensitivity 62% Specificity 53%	SI intensity score $\geq 18.5$ Sensitivity 59% Specificity 57%	No cut-off for any instrument had a combined sensitivity/specificity of at least 80% / 50%	Clinician sensitivity/specificity 71.4% / 62.3% SIS sensitivity/specificity 69.2% / 55.2%.

**Table 7.** Main findings of all studies.

OR=odds ratio. CI=confidence interval. ROC=receiver operating characteristic. AUC=area under the curve.

†per one-step increment on a 25-point score.



#### **4.1 STUDY I: INTERPERSONAL VIOLENCE AS PREDICTOR OF SUICIDE ATTEMPT**

This study was performed when six-month follow-up was completed for the 452 participants included during the first two years, examining the 355 participants with suicide attempt at index and complete KIVS ratings. The mean age was 40 years, 63% were women and the mean KIVS rating was six with no gender differences. During follow-up, 78 persons (22.0%) made a non-fatal or fatal suicide attempt and five of these were suicides.

A KIVS score of six or more was significantly associated with repetition of suicide attempt within six months, with an odds ratio (OR) of 1.81 (95% CI 1.08–3.02).

As secondary outcome, suicide attempt with use of violent method (here defined as cutting, hanging, gunshot, and jumping from height or in front of vehicle in motion) was studied. Of the 78 persons with a repeat non-fatal or fatal suicide attempt, 21 (whereof 16 (73%) women) used a violent method. Having a KIVS score  $\geq 6$  was associated with a violent repeat attempt with an OR of 3.4 (95% CI 1.2–9.5).

#### **4.2 STUDY II: SUICIDAL IDEATION AND BEHAVIOUR AS PREDICTOR OF SUICIDE ATTEMPT**

Study II is based on six-month follow-up data from the 804 participants included from 2012 to 2016. The median age was 33 years, 67% were women and 83% had made a suicide attempt at index. During follow-up, 165 (20.5%) persons made a non-fatal or fatal suicide attempt. There was no significant difference in prevalence of the outcome related to type of self-harm at index, i.e. repeat attempt was as common in the NSSI group as in the suicide attempt group.

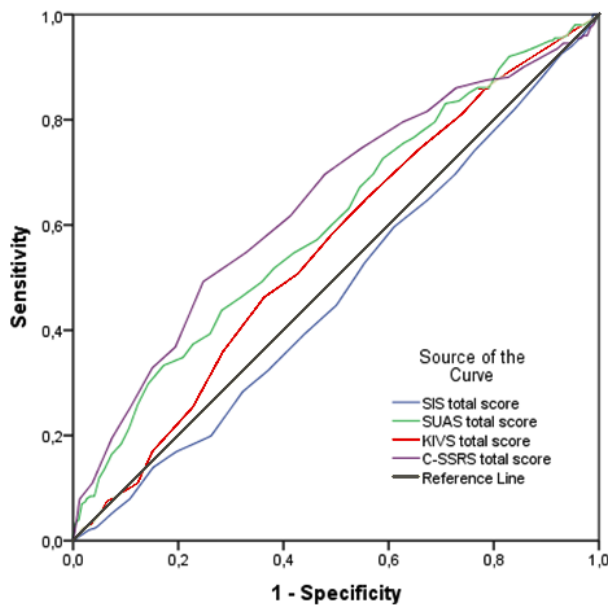
The ratings on the C-SSRS item *most severe ideation* was high and uniform in the sample and did not predict the outcome after adjustment. The C-SSRS total score, intensity score and separate intensity items *frequency*, *duration*, *controllability* and *detering factors* were all significantly associated with a repeat attempt during follow-up with ORs of 1.07 to 1.2. The area under the ROC curve for SI intensity was 0.62 (95% CI 0.57–0.67) and a SI intensity score  $\geq 18.5$  predicted the outcome with a sensitivity of 59% and a specificity of 57%.

#### **4.3 STUDY III: COMPARISON OF PREDICTIVE ACCURACY OF STANDARDISED INSTRUMENTS**

This study is based on the same cohort as Study II and was performed when the one-year follow-up was complete. Analyses were also made for the three-month follow-up to assess the predictive abilities of the instruments KIVS, SIS, SUAS and C-SSRS in this shorter time frame.

During the first three months after the index attempt, 114 persons (14%) made a suicide attempt and 5 (0.6%) died by suicide. In total, 216 persons (27%) made a suicide attempt during the one-year follow-up and 19 (2.4%) died by suicide. Figure 4 shows the AUC of all instruments in predicting suicide attempt at one year follow-up, Figure 5 shows the results for predicting suicide during the same time. SIS was the only instrument that could predict

suicide during both the 3 month and one year follow-up. KIVS, SUAS and C-SSRS could predict suicide attempt during one-year follow-up.



**Figure 4.** AUCs for the total sum of instruments predicting suicide attempt within one year of a self-harm event.

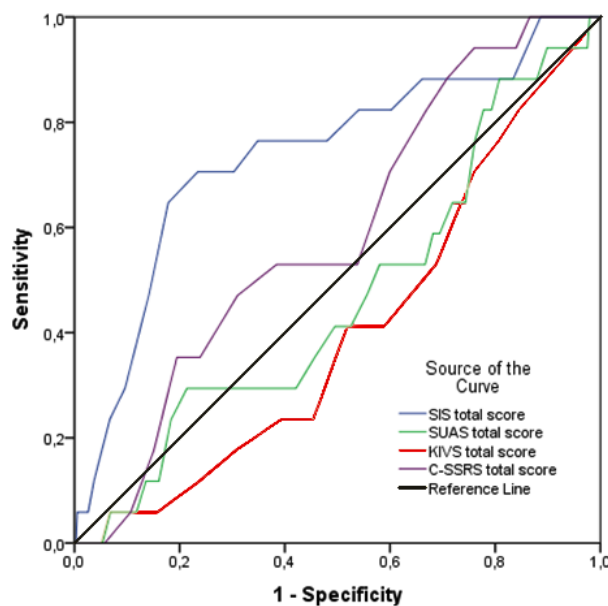
Point estimates of AUCs with 95% CI:

SIS: 0.47 (0.43–0.52)

SUAS: 0.60 (0.56–0.65)

KIVS: 0.56 (0.51–0.60)

C-SSRS: 0.64 (0.60–0.69)



**Figure 5.** AUCs for the total sum of instruments predicting suicide within one year of a self-harm event.

Point estimates of AUCs with 95% CI:

SIS: 0.74 (0.61–0.87)

SUAS: 0.47 (0.33–0.60)

KIVS: 0.40 (0.29–0.53)

C-SSRS: 0.59 (0.47–0.71)

#### 4.4 STUDY IV: CLINICAL SUICIDE RISK ASSESSMENT VS SUICIDE INTENT SCALE

This study is based on the participants in the Stockholm subset of the cohort described above, 479 persons with a median age of 33 years. Of these, 69% were women and 81% had made suicide attempt at index. The clinical suicide risk assessed by the physician at the emergency department and the total score of SIS from the research interview were compared as predictors of the 14 suicides (10 men [6.7% of all men], 4 women [1.2% of all women]) that occurred during the one-year follow-up.

ROC curves were constructed and the AUC for the clinical assessment was

0.68 (95% CI 0.53–0.82). The AUC for SIS was 0.72 (95% CI 0.54–0.89). The optimal cut-off for the clinical assessment was  $\geq 3$  (i.e. high or very high risk), giving a sensitivity/specificity of 71.4%/62.3% and a PPV of 6.1%. Corresponding figures for the optimal SIS score in this sample ( $\geq 18$ ) was 69.2%/55.2%, with a PPV of 6.2%. Defining high risk as having been identified by either one of the assessment methods, sensitivity was 85.7% and specificity 43.8%. The PPV was 4.8% and the false negative rate (the proportion of suicide decedents not identified as having a high risk) was 2/14 (14.3%). If high risk instead was defined as being identified on both assessments, specificity increased to 87.5% combined with a sensitivity of 53.8%. The PPV was 11.5%, and the false negative rate was 6/13 (46.2%). Odds ratios of the different high-risk classifications ranged from 4.1 (95% CI 1.3–13.4) to 8.2 (95% CI 2.6–25.2).

#### 4.5 INTERNAL CONSISTENCY AND INTERRATER RELIABILITY

Table 6 shows the estimates of internal consistency and interrater reliability for the evaluated instruments. Cronbach's  $\alpha$  reflects the degree to which the items of a scale measure the same phenomenon. Values below 0.7 indicate a limited internal consistency. The intra-class correlation coefficient and PABAK measures the extent to which the ratings of two independent raters correlate with each other.

	SIS	SUAS	KIVS	C-SSRS
<b>Internal consistency</b>				
Cronbach $\alpha$	0.78	0.87	0.64	0.55†
<b>Interrater reliability‡</b>				
Intra-class correlation coefficient; 95% CI	0.94 0.85–0.9	0.99 0.97–1.00	0.92 0.82–0.97	-
PABAK	-	-	-	0.63–0.95 for SI 0.70–0.90 for SB

**Table 6.** Internal consistency and interrater reliability of the instruments tested

†for items CS1–5b, CS7–11b, CS12b, 14b, 15b, 17b, and 19b.

‡based on 20 interviews with two raters making separate assessments.

PABAK=prevalence-adjusted, bias-adjusted kappa. SI=suicidal ideation items. SB=suicidal behavioural items.



## 5 DISCUSSION

In this project, we assessed the role of standardised instruments in predicting suicide attempt and suicide in persons already known to have an increased risk of these outcomes. All results point in the same direction: yes, there are statistically significant differences in risk correlated to the factors measured, and no, these differences are not large or specific enough to guide clinical management of an individual patient. The difficulties in predicting an event with a low base rate cannot be overcome using the instruments tested.

### 5.1 METHODOLOGICAL CONSIDERATIONS

#### 5.1.1 Population and study sample

The population in this project consist of patients who, in connection with a self-harm event, sought or were referred to psychiatric assessment at a psychiatric emergency department, in psychiatric in-patient care or in a medical emergency department. The sampling frame consists of individuals from this population who were available in terms of 1: being on the premises when research staff was present, 2: speaking Swedish, 3: being able to participate in an interview lasting about 1.5 hours, 4: being able to understand the information given and give an informed consent.

Regarding the first criterion, research staff was not on duty every day during the inclusion period (April, 2012 to April, 2016). However, all kinds of days (weekdays, weekends and holidays such as Christmas and Midsummer) were covered. The research staff had a close collaboration with the regular staff, to get information about potential study participants at the psychiatric emergency department or patients who had recently been admitted to hospital wards. Patients who were discharged or transferred to another clinic directly after assessment at the emergency ward were less likely to be available for study participation. This means that the study sample probably includes persons with more pronounced psychiatric illness, higher perceived suicide risk and/or medically more severe self-harm than the population at large.

Thus, the results are not generalizable to all persons who self-harm. It is also possible that the study sample has been given more extensive treatment and, at least initially after the self-harm event, had fewer opportunities for repetition. This could lessen the impact of the studied risk factors on the outcomes of interest.

Regarding criteria 2–4, these excluded non-Swedish speaking patients as use of an interpreter was not feasible within the study. The proportion of study participants born outside Sweden was 13.4% (95% CI 11.2–16%); the proportion of Swedish residents born in another country was 15.4% to 17.9% during the inclusion period (150). Even though the proportions are quite similar, the language criterion implies that the results might not be applicable to persons from all cultural backgrounds. Criteria 2–4 also excluded patients with symptoms interfering with verbal communication e.g. intoxication, confusion, severe psychotic symptoms and aggressiveness. If the patient was admitted to hospital and these symptoms abated within a few days, they were eligible for inclusion, but it is still possible that the results from this project cannot be generalised to all diagnostic categories.

#### *5.1.1.1 Completeness of data*

The participants were free to abort the interview, and not all rating scales were completed by all participants. There was no significant differences regarding age, sex, type of index attempt or prevalence of either outcome between participants with and without complete ratings (see supplementary Table 1, Study III).

#### **5.1.2 Identifying the outcome**

Information on suicide attempts during follow-up was gathered from the medical record which likely minimised loss to follow-up as the participants did not have to be contacted again for a new interview. Even though the medical record systems used at the three sites do not have complete coverage of all potential caregivers (e.g. of all medical emergency departments, all primary care and psychiatric outpatient settings), one-year follow-up data was available for 775 participants (96%).

In Study I and II, we used medical record data for all outcome events. In the analyses, only events clearly described as suicide attempts or suicides were included. This could imply a risk of underestimating the incidence of both repeat suicide attempt and suicide. However, the non-fatal repetition rate is similar to that of other cohorts where the patient report is used to identify this outcome (29). Two non-systematic observations from reading 422 of the medical records were that many self-harm events are not registered with an ICD-10 diagnosis, merely noted in plain text, and some self-harm events are registered with an ICD-10 diagnosis several times, on different dates. This does not affect the studies in the present project but could be worth to bear in mind when relying on register data alone for non-fatal self-harm outcomes.

When register data was obtained from the National Cause of Death register, the deaths caused by events of undetermined intent were included in the outcome suicide to avoid underestimation of the suicide risk, in line with previous research. There is of course a possibility that some of these events were accidents, in which case the suicide risk is overestimated in Study III and IV. The one-year suicide rates were 2.4% in Study III and 2.9% in Study IV. If the events of undetermined intent are excluded, the one-year fatal repetition rate is 1.9% in Study III and 2% in Study IV.

In the systematic review by Owens from 2002, the median one-year suicide rate was 1.6% with an interquartile range of the point estimates from the individual studies of 0.8–2.6% (28). In the systematic review by Carroll from 2014, the one-year fatal repetition rate based on all studies reviewed was 1.6% (95% CI 1.2–2.1) (29). A higher fatal repetition rate was found in samples with an above-average proportion of men, in older samples and in samples with below-median proportion of poisoning used at the index episode. The proportion of male participants in Study III and IV was 33%; below the average reported by Carroll, and the median age is 33 years, almost identical to the one reported. However, the proportion of participants using poisoning at the index self-harm event was lower in our sample; 63% compared to the median of 90%. For this group, the fatal repetition rate reported in the

systematic review was 2% (95% CI 1.2–3.2%). It is known from previous studies that method of non-fatal self-harm has an impact on future suicide risk (65), and it is possible that the relatively high suicide rate seen in the present studies is explained by this factor.

### **5.1.3 General considerations**

In Study I, only participants with a suicide attempt at index were included, to keep this study as similar and comparable to the original KIVS study as possible. During the inclusion period following the first study, and when analysing the complete data set, it was noted that many participants reported mixed intentions, sometimes changing the self-reported level of suicidal intent from the first contact with a health care professional to the research interview. This can be interpreted in different ways: the patient can be seen as lying or manipulating, telling the story that fits best at a specific moment, or it can be seen as a reflection of how difficult it is to know the true intention of our actions, if there is such a thing. It was also noted that a large proportion (68%) of participants with a non-suicidal index event had made previous suicide attempts, and that there were no significant differences regarding outcome (neither suicide attempt nor suicide) between the groups. In study II–IV all participants were included regardless of index type of self-harm.

## **5.2 INTERPERSONAL VIOLENCE ASSESSED WITH THE KIVS**

Interpersonal violence measured with the KIVS was found to be associated with an increased risk of subsequent suicide attempt within six months (Study I) and one year (Study III). It was not correlated to suicide in the one-year follow-up, in contrast to the findings in a previous study where the predictive ability of KIVS was assessed against five suicides during a four-year follow-up, and exposure to violence in childhood and expression of violence as an adult was associated with an increased risk of suicide (132).

The KIVS total score was marginally better than chance in predicting the composite outcome non-fatal and fatal suicide attempt at six months with an AUC of 0.57. In predicting non-fatal suicide attempt within one year, the AUC was 0.56. Sensitivity and specificity were poor, and even the negative predictive value (the proportion of participants classified as low risk, who did not make a suicide attempt during follow-up) of 77% was low compared to the other instruments assessed in Study III. These results indicate that experience of interpersonal violence assessed with the KIVS cannot on its own be used as a clinically meaningful predictor of repetition within six months or one year. An evaluation of the secondary outcome repeat suicide attempt with a violent method in Study I found that a KIVS score  $\geq 6$  predicted this outcome with an OR of 3.4. If this correlation was evaluated in women only the OR was almost five with quite a wide confidence interval of 1.32–17.26. This might indicate that the KIVS score is more strongly correlated with violent reattempts, and that women are more vulnerable to this effect, but if thought to be of interest, this should be studied as a primary outcome measure in a larger cohort.

The interpersonal-psychological theory posits that a suicide can only occur if there is a desire to die and a capability for suicide (103). It is not clearly stated but reasonable to assume that, once acquired, the capability remains fairly stable and it is by variation of the desire to die

that suicide risk can be modified. It has been suggested that experience of interpersonal violence increases the suicide risk via an increased risk for depression and substance abuse (151, 152). A majority of the study participants were admitted to hospital at the index attempt and later discharged to outpatient treatment. It is possible that the factors influencing the desire to die (or to use the framework of the integrated motivational-volitional model: keeps the motivational phase active) are addressed in treatment, lessening the connection between the experiences measured by the KIVS and the outcome. Interpersonal violence is associated with an increased suicide risk in a life-time perspective (54, 153), but it seems to be of little relevance in prediction of one-year fatal repetition.

This aside, the instrument could still be of use. The negative health effects of exposure to and expression of interpersonal violence are well documented, as is the low level of exploration of these issues in Swedish health care settings (154). A short structured instrument could make it easier to ask these sensitive questions and take the answers into consideration in treatment planning and/or referral to other facilities (e.g. social services and special projects for those who harm others).

### **5.3 SUICIDAL IDEATION AND BEHAVIOURS ASSESSED WITH THE C-SSRS**

Suicidal ideation (SI) and behaviours assessed with the C-SSRS were used as predictors on non-fatal and fatal suicide attempt in Study II and as predictors of suicide attempt and suicide as separate outcomes in Study III.

In Study II, the total C-SSRS score and the SI intensity score were associated with non-fatal and fatal suicide attempt within six months of the index event. SI severity was not associated with this outcome after adjustment for other risk factors, which is likely due to the fact that a majority of participants reported very severe suicidal ideation, and where there is little or no variation in the rating, there can be no separation of sub-groups. The adjusted OR for the SI intensity score was 1.07, which means that for each one-step increment in score, the odds of the outcome increase by 7%. If this score changes from 5 to 15, the odds of the outcome increases by 97% ( $1.07^{10}=1.97$ ); a change from 5 to 25 increase it by almost four times ( $1.07^{20}=3.87$ ). The AUCs for the total score and the SI intensity score showed that they were marginally better than chance in classifying the outcome correctly, and it was not possible to find a cut-off that yielded acceptable combinations of sensitivity and specificity for the rating scale to be of clinical use in predicting suicide attempt on an individual level.

Similar results were found in Study III where the total score was used as predictor. There was no correlation between the C-SSRS total score and suicide during follow-up, and results similar to those of Study II in predicting suicide attempt. Suicide has not previously been evaluated as an outcome in prediction studies employing the C-SSRS, so no comparisons can be made.

Most previous prediction studies using the C-SSRS have not been focused on repetition of self-harm. One exception is the study by Posner and co-workers, on 124 adolescents with an actual or interrupted suicide attempt within 90 days of inclusion, where lifetime worst-point SI severity predicted suicidal behaviour (actual, aborted and interrupted suicide attempts and



preparations) within a six month follow-up (13). SI intensity was not studied as a predictor in this cohort. The proportion of actual suicide attempt at baseline was low in this sample, 13%, and in such a context severe SI could serve as a risk factor. This could also explain the strong correlations between SI severity and future suicidal behaviours (SBs) observed in a meta-analysis of clinical trials where C-SSRS was used to detect treatment-emergent suicidality (155). Less than 5% of all study participants endorsed ever having suicidal ideation with some intent and plan, and this was associated with an OR for future SBs of 18.7 and 78.6 in the psychiatric and non-psychiatric populations, respectively.

The findings in Study II and III on SI intensity and the C-SSRS total score are in line with previous research. SI intensity has been associated with an increased risk of suicide attempt in adolescents and young adults seeking psychiatric emergency treatment (140, 141) and the intensity item deterrents was associated with suicide attempt during a short-time follow-up in adolescents with previous suicidal behaviour (142). The total sum of C-SSRS was predictive of suicidal behaviours within six months in an adult psychiatric inpatient cohort (143), however neither the prevalence of previous self-harm nor the proportion of actual suicide attempts during follow-up was reported, making comparisons with results from Study II difficult.

Even though the C-SSRS total score or subscales cannot predict suicide and are only modestly correlated to non-fatal repetition, the instrument could be of use in structuring the patient report and using defined terms for different suicidal behaviours. Some aspects of its psychometric properties could however be discussed:

The C-SSRS is presented as assessing four constructs: suicidal ideation severity, suicidal ideation intensity, suicidal behaviours and actual or potential medical severity of previous attempts (13). This is stated in the study introducing the scale, with limited theoretical backup and no factor analysis. A later study of the underlying structure of the English version in an adult psychiatric inpatient sample found support for a two-factor solution, with severity of ideation and behaviours loading on one factor and intensity of ideation on the other (143). In an adolescent outpatient sample, testing the Turkish version, a three-factor solution fitted the data better (156). Experiences from the current project were that the SI severity items were fairly easy to understand and score, (e.g. have you in the past 30 days had the thought that you would be better off dead, yes/no?) as were the behavioural items. This was reflected in robust measures of interrater reliability for the behavioural items with prevalence-adjusted, bias-adjusted kappa (PABAK) between 0.70 and 0.90. Regarding the internal consistency, Cronbach's  $\alpha$  for the five items assessing SI severity was 0.64 whereas the PABAK for the single item most severe ideation, which sums up SI severity, was 0.95.

Cronbach's  $\alpha$  for the SI intensity subscale was 0.49 which could indicate that this subscale measures more than one underlying construct, similar to the findings in a validation study on the Spanish version of the C-SSRS in an adult psychiatric outpatient sample (157). These items were sometimes challenging to assess properly. Many respondents reported both maximum frequency and maximum duration of suicidal thoughts, i.e. thoughts appear many times each day, and last at least 8 hours or are persistent. This can be true if "many times" is

not more than three times, otherwise it does not work out. The responses to the item deterrents also needed consideration. Some participants who had just made a suicide attempt initially stated that they would never attempt suicide because of their children or religious beliefs. This might have been their sentiment during the interview, but considering the very recent suicide attempt it clearly had not been the case during the whole past month. This item, which also has a slightly confusing response alternative (0=does not apply) had the lowest PABAK, 0.63 compared to 0.89–0.92 for the other SI intensity items.

It might seem petty to point out these inconsistencies, but if these aspects are important to measure, it would be important to measure them correctly. The instructions in the C-SSRS are not always clear and can be misunderstood, as has previously been pointed out (14). An evaluation of the psychometric properties of the instrument noted that more research was needed to assess if the more granular C-SSRS categories were motivated (16). The assessment of convergent and divergent validity (the extent to which test result correlate to another test said to measure the same construct, and the extent to which it does not correlate to a test that measure something supposed to be completely different) has mainly been assessed in adolescent and adult populations with mood disorders (13, 143, 156, 157) and it is not evident that these results can be transferred to children, older adults, or to all diagnostic categories (e.g. psychosis, autism, intellectual disability or mild cognitive impairment) (158).

## **5.4 COMPARISON OF THE RATING SCALES**

When the SIS, SUAS, KIVS and C-SSRS were compared as predictors of suicide attempt and suicide as separate outcomes, the main findings were that the SIS was the only instrument reasonably able to predict suicides whereas the other rating scale could predict suicide attempt within a year of the index event, and that the SIS and the C-SSRS could predict suicide and suicide attempt respectively also at a three month follow-up. The overall predictive accuracy of all the tested instruments was limited.

The findings for SIS are in line with most but not all previous studies, where positive results have been reported from larger samples with long follow-up times (148, 159). In comparison, Study III is one of the largest, with among the shortest follow-up times. The predictive accuracy was evaluated for the first three months of follow-up with partly excellent results; an AUC of 0.94 and sensitivity/specificity of 100%/81.9% for a total score  $\geq 21$ . The PPV was 2.8%. Since the results were based on a very small number of suicides ( $n=4$ ) the implications of this result should not be exaggerated.

The results for the KIVS are discussed in section 5.2. Concerning SUAS, Niméus and co-workers found the total score to be predictive of fatal repetition within a year in a cohort of suicide attempters (145), but this could not be replicated in the present sample. The cohorts likely represent somewhat different populations as all participants in the Niméus cohort had been treated in a medical intensive care unit after a suicide attempt and then transferred to a suicide research ward where they were asked to participate in the study after about a week. There was also a higher one-year suicide rate, 4.2% compared to 2.4% in this sample.

The C-SSRS did not predict suicides. In a recent meta-analysis of 71 studies evaluating suicidal ideation as predictor of suicide over a mean follow-up time of 9 years, the pooled odds ratio of suicide associated with suicidal ideation was 3.4, with sensitivity/specificity of 46%/81% in psychiatric samples (160). In studies with a high proportion of patients with suicidal ideation and in hospital-treated samples the specificity was lower. Similar results were found in a meta-analysis of suicidal ideation and behaviours as risk factors for both suicide attempt and suicide over a mean follow-up time of 4 years (161).

## **5.5 THE CLINICAL SUICIDE RISK ASSESSMENT AND SIS**

The results in predicting suicide within one year of the index self-harm event were very similar for the Suicide Intent Scale and the clinical risk assessment. The sensitivity, specificity and positive predictive value were limited for both methods. These estimates changed in a predictable way if high-risk status was made easier (identified by either method yielded increased sensitivity) or more difficult (identified by both methods increased specificity) to obtain. The pre-specified cut-off for SIS resulted in non-significant results and it should be noted that all significant results were based on optimal performance of the respective assessment methods in this specific sample, and might not be generalizable to other samples. These results do not support that a standardised instrument such as SIS has better predictive properties than the clinical risk assessment. There are no previous studies comparing the clinical risk assessment to the SIS, or any other structured instrument with suicide as an outcome. Previous studies comparing rating scales to the clinical risk assessment regarding non-fatal self-harm have come to different conclusions. In one study, the clinical global evaluation was compared to the Manchester Self-Harm Rule (MSHR), and the authors suggested prioritising the high sensitivity of the MSHR over the clinical risk assessment which had a higher specificity (162). This study was performed in non-psychiatric emergency settings, where the decision to be made was if the patient should be referred to a specialist assessment or sent home. In such a context, a high sensitivity and a large proportion of false positives is not only acceptable but also preferable. At a psychiatric emergency department however, which would be the recipient of these referred patients, it is neither feasible nor desirable to admit everyone with high risk according to some highly sensitive but unspecific risk scale.

In another study, the predictive performance of the clinician was compared to that of the patient and the SAD PERSONS scale, the Barratt Impulsiveness Scale and the MSHR in a sample of persons who had been referred to liaison psychiatric services after self-harm. None of the risk scales performed better than the clinician or the patient in predicting repeat self-harm within six months, and the authors concluded that the use of risk scales might be a waste of resources (163). This was questioned by Fazel and Wolf, who pointed out that another way of describing the results, which also applies to the present study, is that the clinician is not better than the risk scales and that the transparency and reliability of the risk scales are important advantages (164).

## **5.6 WHY IS IT SO DIFFICULT TO PREDICT SUICIDE ATTEMPT AND SUICIDE?**

Suicides are tragic. This unfortunately has no impact on their predictability. Infrequent and multifactorial events will always be more difficult to predict than frequent, well-understood events.

### **5.6.1 A suicidal act is the result of a temporary state of mind**

The above quote from Merete Nordentoft (165) signals an important aspect: even though there can be a suicidal process where ideation precedes preparations which precede action, the act can be triggered suddenly, by factors unknown to the patient or the clinician at the time of assessment. The time from onset of thinking about attempting suicide to initiation of an attempt was explored in a sample of suicide attempters where 48% reported that this time span was less than ten minutes (166). Less than five minutes from decision to action was reported by almost a quarter of survivors of near-lethal attempts (167). This indicates that at least for some persons attempting suicide, there might be very limited possibilities for other people to intervene.

Suicide risk assessment – by use of structured instruments or a clinical interview – consists of gathering information present at the time of assessment. The idea of assessing suicide risk in this manner rests on the underlying assumption that lack of knowledge is the source of uncertainty regarding suicide risk, and the more that is known about the patient's present status, the more accurately suicide risk will be assessed and managed. There are however chance factors that will influence the suicide risk – factors that cannot be evaluated since they are not present or imaginable at the time of assessment (168). These aspects highlight the need of preventive measures on a societal level like raising community awareness, restricting means, and eliminating barriers to help (165).

### **5.6.2 Suicide is a rare event**

In Sweden, three to four persons die by suicide each day. Table 7 is modified from Galen & Gambino's seminal work from 1975 [Beyond Normality quoted in (169)] and shows the positive predictive value (PPV, the proportion of subjects with a positive test result that has the outcome) of a hypothetical test, at different base rates and different combinations of sensitivity and specificity. At a base rate of 10/100,000 (similar to the annual suicide rate in Sweden), a test with 90% sensitivity and 90% specificity will have a PPV very close to zero. None of the instruments in this project (with the possible exception of SIS predicting suicide at three months follow-up), or in any of the studies referenced have similar accuracy statistics.

	Sensitivity, %				
Specificity, %	50	70	90	95	99
	Base rate 10/100,000 – about the annual suicide rate in Sweden.				
50	0	0	0	0	0
70	0	0	0	0	0
90	0	0	0	0	0
99	0	1	1	1	1
	Base rate 500/100,000. A previous suicide attempt is suggested to increase the risk 50–100 times, i.e. at least to this base rate.				
50	1	1	1	1	1
70	1	1	1	2	2
90	2	3	4	5	5
99	20	26	30	32	33

**Table 7.** The PPV in percent at different base rates and different combinations of sensitivity and specificity. Adapted from Galen & Gambino.

In this project, the one-year incidence of suicide after self-harm was 2.4% which corresponds to a suicide rate of 2,400 suicides/100,000 persons and year. At this base rate, and with a SIS total score cut-off chosen to maximise both sensitivity and specificity, the positive predictive value was 3.9% (see Table 2, Study III). This means that in this sample of patients with a high one-year suicide risk, high-risk classification according to the only instrument where there was a correlation between total score and future suicide, was correct in only 3.9% of the cases.

Another example can be drawn from a systematic review and meta-analysis on prospective controlled studies on clinical factors associated with in-patient suicide. The authors found a strong correlation between high-risk status (categorised on the basis of multiple risk factors e.g. a psychotic disorder, prior self-harm, depressed mood, anxiety) with an OR of 10.9, and pooled estimates of sensitivity/specificity of 64%/85% (72). In spite of the large OR and fair accuracy statistics, the positive predictive value of the high-risk categorisation was only 1.4% because of the low base rate of in-patient suicides.

### 5.6.3 The problem with a low PPV

“It is ironic that if we had a perfect predictive instrument we would not be able to recognize it because it could never be validated by its critical outcome criterion.”

*Jerome A. Motto, 1991 (170).*

A low PPV becomes a problem if someone is expected to act on the result of the test. What actions can be motivated if only a small minority of those identified by the test will actually have the outcome? All interventions carry a cost, in monetary terms as well as time and commitment, and not all interventions are desired by the person at risk.

A related problem concerns those not identified by the test as having a high risk. Depending on how high-risk status was defined in Study IV, two to six persons who died by suicide were classified as having a low risk, i.e. the false negative rate varied from 14.3% to 46.2%. This inherent problem of categorization based on risk assessment has been described by Large and co-workers, emphasising that the low-risk group often is so large that a small proportion of it contains more persons than the larger proportion of the smaller high-risk group – thus most suicides will occur in the low-risk group (72, 171). This implies that suicide rates might not be much affected by reserving some interventions for those with high scores on a rating scale. In this context, it is also worth bearing in mind that a large proportion, 50–68%, of all first attempts result in death (172-174). Seeing as a previous attempt is considered to be the major risk factor for suicide, these persons might have had small chances of receiving a high-risk classification.

The low PPVs found in this kind of studies are particularly troublesome. A low PPV in a test for something that either is or isn't prevalent at the time of the test is problematic for the reasons given above. But all the PPVs reported here and in most studies on suicide prediction represent the proportion of high-risk individuals who will have the outcome in spite of this identification and in spite of the treatment given. In the larger sample used in Study II and III, 93% of participants were admitted. Treatment data was not registered, but the impression after completing the follow-up was that the vast majority at least in the Stockholm subset had pharmacological treatment, that virtually all who had been inpatients were offered outpatient treatment, not only for follow-up prescription of medicine but most often with some psychotherapeutic or otherwise supportive contact. Care plans and safety strategies were often discussed. It follows that there might be very little room for improvement on the rates of suicide attempt and suicide in this group were the studied instruments included in clinical routines.

### 5.6.4 The low predictive accuracy of the major risk factors

Sometimes terminology clouds the mind. The major risk factors, like previous self-harm in combination with psychiatric diagnosis, are not major in a way that is helpful to prediction in the individual case.

A factor can be of major etiological importance without being helpful in prediction just as a factor with good predictive properties can be unrelated to the causal mechanism of the

outcome. A factor that is present in some group members and associated with a two to fivefold increase in the risk of a specific outcome cannot discriminate between groups that will and will not have that outcome (48). Even a factor that increases the risk of an outcome by 200 times cannot completely discriminate between groups (175). Most risk increases observed in this project are much smaller than this: in Study I, ORs of 1.81–3.2 were seen, in Study II the largest possible increase in odds was about 25 times (the OR was 1.08 for the total score, which has a range of 0–42) and in Study IV the ORs ranged from 4.1 to 8.2. In a meta-analysis from 2017, the authors examined 365 longitudinal studies on prediction of suicidal ideation and behaviour published over the past 50 years, with a total of 3,428 risk factor effect sizes. Weighted mean odds ratios and accuracy statistics (AUC, sensitivity, specificity) were calculated for all studies and for separate categories of risk factors (biological, demographic, psychopathology, personality traits, psychosis, prior self-harm etc.). The weighted mean odds ratio for prediction of suicide attempt was 1.51, and the corresponding figure for suicide was 1.50. The diagnostic accuracy was poor for both outcomes with weighted mean AUCs of 0.58 and 0.57 respectively (47). Similar findings were observed in the separate meta-analysis of suicidal ideation and behaviour as predictors for suicide attempt and suicide: the weighted mean odds ratio was 2.16 for prediction of suicide attempt and 1.54 for suicide. For both outcomes, there was evidence of publication bias and when this was accounted for, ORs were reduced to 1.68 and 1.51 (161).

#### **5.6.5 The low predictive accuracy of many risk factors in combination**

In 1983, Alex Pokorny published a paper describing his attempts to predict suicide in a cohort of 4,800 psychiatric inpatients. Data collection was thorough with use of many diagnostic and other rating instruments available at the time, including structured observation by the ward nurses and an interview with a research social worker. With about 100 items per patient to evaluate, it was not possible to find a set of items that in a clinically meaningful way could identify the patients who later died by suicide. Pokorny concluded:

“The negative findings of this study have clear implications. The court and public opinion seem to expect physicians to be able to pick out the particular persons who will later commit suicide. Although we may reconstruct causal chains and motives after the fact, we do not possess the tools to predict particular suicides before the fact” (169).

He reanalysed the data a decade later, using logistic regression instead of discriminant analysis, with the same results (176). In the validation study of the suicide risk estimator published by Motto in 1985 (118) and mentioned in section 1.5, it was not possible to replicate the original findings. The author concluded:

“Suicide may be a behavioural outcome reached by so many different pathways that no constant set of clinical features can serve as an accurate prediction equation. [...] Our findings highlight the likelihood that suicide scales derived by multivariate analysis of a large number of [...] variables may tend to be arbitrary and sample specific” (177).

### **5.6.6 Barriers to perfect clinical predictions**

Clinicians make lots of assessments and predictions, but there are few if any formalised tests of their accuracy. The only way to improve one's predictive accuracy is to make many predictions which are precisely defined regarding the outcome, the time frame and the estimated probability in numerical terms, to get feedback on every prediction on the basis of which one adjusts one's future predictions (178). This might be challenging when it comes to suicide. Being precise would require a statement like "I estimate that this person has a 3% probability of dying by suicide within the coming year" and although the outcome and timeframe can be formulated, many feel awkward on having to decide on a numerical value (178). This might be overcome, but the main problem lies in the next step: getting feedback. Most of the time, the patient will not die, whatever the estimated suicide risk. For the clinician, suicides are rare events even in high-risk populations and the possibility of getting enough feedback is (thankfully) small. An assessment of increased suicide risk would also elicit some intervention to minimise it, and with a successful intervention the probability of a correct prediction lessens. Another complicating factor regarding feedback is that suicides are not similar – the "feedback" gotten from one will not necessarily help in another case. One patient dies by suicide, off medication and in the initial phase of a psychotic relapse, in spite of the carefully made safety plan and the well-informed next-of-kin. Another person with a similar diagnosis dies to everyone's bewilderment despite medication adherence, no observed symptom recurrence and no signs of stress or worry. What lessons are to be learned from the first case that could have prevented the second?

### **5.6.7 Big data and machine learning cannot circumvent the low base rate**

A fair amount of hope has been placed into the development of so-called third-generation prognostic models. These are proposed to differ from first generation, i.e. clinical assessment and second generation, i.e. most risk assessment instruments in that they are composed not only of statistically derived static factors but also of dynamic risk factors which could be measured in real-time. The latter is made possible with the use of smartphones, frequent symptom ratings and continuous access to social media accounts (179, 180).

This has been explored in several studies using machine learning techniques to extract risk factors from large datasets in order to construct mathematical prediction models for suicide and suicide attempt. Among other institutions, the US Army has devoted resources to this line of research in response to the increasing suicide rate among its soldiers. Using multiple data sources and employing advanced statistical methods and machine learning on a sample of more than 40,000 soldiers with 68 suicides, the following risk factors were identified: male sex, older age at enlistment, weapon ownership, crime perpetration, previous psychiatric disorder and previous suicide attempt (181). In this sample, 53% of the suicides occurred in the 5% identified as having the highest suicide risk. In another study, the medical records of 100 suicide decedents and 140 matched controls were analysed with a machine-learning system able to recognise patterns associated with a known outcome. This revealed that the words agitation, frightened and adequate were particularly common in the records of suicide



decedents, whereas neut[rophils], presbyopia and dishevelled were associated with psychiatric disorder without suicide. This is not a finding of immediate clinical use. The overall accuracy (which in these studies is defined as (sensitivity + specificity)/2) of the different models tested was 60–69% (182) which is fairly similar to some of the results in the current project (e.g. the accuracy calculated in this way for the clinical risk assessment predicting suicide during a one-year follow up was 67%).

In another recent effort, genetic information from repeated blood samples was combined with self-assessment of anxiety and mood to derive a predictive model for increased suicidal ideation or hospitalisation due to suicidal ideation (SI) (i.e. less serious outcomes than suicide attempt and suicide). Among a very large number of findings, it was found that the genetic information alone could not predict increase in SI, that information regarding previous suicide attempt and current stress were predictive of this outcome and that the combination of genetic and other information might improve prediction of increased SI, in the dataset that gave rise to the model (183). Many of the other findings concerned the activation of different genes and the possible associations between this and suicidal ideation, which might be interesting from an etiological point of view.

In an ongoing study, the Durkheim Project, a real-time monitoring system is tested in US army veterans. Accessing the study participants' social media accounts and combining their online activity with individual history, suicide risk is updated whenever new information arises and a risk estimate is delivered to the clinician together with a probability of the risk estimate (184). As of yet, it is a non-interventional study and there are no published results. Using an approach like this could potentially be highly problematic, not only from an integrity perspective but also in terms of transparency of how decisions and assessments are made (185). If all suicides are to be prevented with such an approach, everyone will need to be monitored. One could also speculate as to what would or should happen if an algorithm identifies a suicide risk that is denied by the person in question. Those familiar with the Precrime Unit (which, based on the visions of the precognitives, imprisons persons due to crimes they are predicted to commit, regardless of what they have done or claim they will do next) (186) might be apprehensive of such a scenario.

In a very recent systematic review of prediction models of suicide and suicide attempt, models derived from 2005 and onwards (and including the risk estimator from 1985) were tested and simulations of the models' predictive accuracy were made using large datasets. The results presented are strikingly similar to those of Galen & Gambino, Pokorny, Large and others, and the authors conclude that also the modern, big-data-derived suicide prediction models have a near zero predictive validity (187).

## 5.7 HINDSIGHT BIAS, AND PREDICTION OUTSIDE PSYCHIATRY

“It’s tough to make predictions, especially about the future.”

This quote has been attributed to Yogi Berra and others, and at first it might sound like a joke, or plain stupidity. But when something has happened it is surprisingly easy to forget that there is a difference between (seeming to) understand why it happened and being able to foresee it, based on the information present before the event. Hindsight bias, the tendency to overestimate the predictability of an event (or one’s own prediction skills), when one knows that the event occurred (188), has been studied in different settings and it is a recurrent finding that knowledge of the outcome can affect the estimate of the risk and of the predictability of the event, as well as the appraisal of the actions taken before the outcome. In a recent study, clinicians were asked to rate the quality of care in a retrospective case note review, where the alleged outcomes were randomized. The quality of identical care was rated as low if the outcome was negative and adequate or good if the outcome was positive (189). In another study, knowledge of the fictional outcomes suicide and violent behaviour affected the risk estimates in a series of hypothetical cases (190). Evidence suggests that more comprehensive knowledge and actual experience of the task to be appraised can lessen the impact of hindsight bias (191).

Predictive accuracy has been studied in many disciplines – the stock market, sports, politics and weather just to name a few. To quote the authors of a study evaluating over 6,000 predictions made by 68 stock market forecasters, a few forecasters are “uncannily accurate”, but on the whole the results seem to be close to random (192). Weather forecasting is more successful. There is vast knowledge about what causes common weather phenomena and there are innumerable weather stations continually measuring data known to be essential for weather forecasting. Since there always is weather, there is continuous feedback which makes it possible to adjust and perfect the forecasting algorithms. Under these circumstances, and with the use of supercomputers, weather can be accurately predicted about 80 percent of the time for a seven-day forecast (193). If one wants to predict the weather more than eight days ahead, it is better to rely on yearly average than the data present today (194). Even if the input data were perfect, and the algorithms flawless, it is not expected that weather predictions will ever be completely accurate in a time span longer than 14 days, because of the complex interactions between a multitude of factors (195). Not all weather phenomena are equally predictable, though. Temperature and precipitation and also more rare events such as hurricanes and floods are possible to predict whereas earthquakes still are close to unpredictable (194).

“The problem of prediction is not unique to suicidal behaviour, rather, it’s the theoretical basis for prevention in many disorders where the most successful strategy has been to focus on whole-population approaches rather than focusing on individuals at high risk.”

*Simon Hatcher, The International Handbook of Suicide Prevention, 2016 (115).*

Many medical conditions are better understood in terms of aetiology, natural course and treatment response than suicidal behaviour. Yet death is an accepted albeit sad outcome of disease. In Sweden, 85 persons die due to cardiovascular disease and 65 persons die of cancer each day (41), but it has never been mandatory to report these deaths and scrutinise the actions of the treating physicians to assess what kind of mistakes were made that allowed for all these people to die. But in the case of suicide, despite vast empirical support of its unpredictability in the individual case, there still seems to be a need to hold *someone* responsible for it. This is an intriguing psychological phenomenon far beyond the scope of this project.



## 6 CONCLUSIONS AND PRACTICAL IMPLICATIONS

The standardised instruments studied in this project cannot, in a clinically meaningful way, predict suicide attempt or suicide. These findings are in line with the past 50 or so years of research, and more studies with a similar approach would not seem to be needed. Regarding future directions of research, the more recent suicide prediction approaches with constant monitoring not only of symptoms but of people's social media interactions have ethical issues which are not easily resolved.

The studies presented here do not indicate that all standardised instrument are completely useless, as other potential areas of usage have not been examined. Thus, the instruments might still be valuable as a way of structuring the clinical assessment, to ensure that potentially important experiences are explored or as an aid to monitor change in potentially relevant symptoms.

Neither do the results of these studies indicate that clinical risk assessment should be abandoned just because it will not prevent all suicides by way of predicting them. Risks that are impossible to assess with precision can still be managed, and persons struggling with suicidality will not benefit from clinicians' dejection and cynicism. The continued sanity and optimism of clinicians assessing suicidal patients, on the other hand, would benefit from more realistic expectations regarding the prediction and prevention of death, more in line to that which is expected of our colleagues in other fields of medicine. I sincerely hope that a more balanced view of this will emerge.



## 7 SVENSK SAMMANFATTNING

### Syfte

Avhandlingens syfte har varit att undersöka hur väl suicidförsök och suicid efter självskada kan förutsägas med hjälp av fyra skattningsskalor baserade på kända riskfaktorer för dessa utfall.

### Metod

Alla delstudier baseras på en klinisk kohort med patienter som sökt eller hänvisats till en akut psykiatrisk bedömning efter en självskada (indexförsöket). Inklusionen ägde rum i Stockholm, Göteborg och Umeå under åren 2012 till 2016. Patienterna kunde inkluderas om de inom den senaste veckan genomfört en självskada med eller utan suicidal intention. De skulle också kunna delta i en ca 1,5 timme lång intervju på svenska för insamling av baseline-data inklusive skattningsskalorna. För att möjliggöra uppföljning i journal och genom uttag från Dödsorsaksregistret skulle deltagarna bo i respektive sjukhus upptagningsområde och ha svenskt personnummer. Studiedeltagarna identifierades i samråd med ordinarie personal och forskningsintervjun genomfördes av psykiater, psykolog eller psykiatrisjuksköterska. De primära utfallsmåtten var suicidförsök och suicid inom ett år från indexförsöket och information om dessa inhämtades dels genom journalläsning, dels genom registeruttag. De skattningsskalor som undersöktes var:

- Karolinska Interpersonal Violence Scale (KIVS), som kartlägger utsatthet för och användande av interpersonellt våld i barndomen (6–14 år) och vuxen ålder ( $\geq 15$  år) (*Studie I och III*).
- Columbia-Suicide Severity Rating Scale (C-SSRS), som karakteriserar suicidtankar med avseende på allvarlighetsgrad och intensitet och också värderar förekomst av suicidalt beteende och den medicinska allvarlighetsgraden hos genomförda suicidförsök (*Studie II och III*).
- Suicide Assessment Scale (SUAS), som skattar allvarlighetsgrad i olika psykiatriska symtom (bland annat nedstämdhet, ångest, impuls kontroll och suicidtankar) (*Studie III*).
- Suicide Intent Scale (SIS) som värderar omständigheterna vid ett genomfört suicidförsök med avseende på bland annat möjlighet att bli upptäckt, avsikt med försöket och personens uppfattning om den valda metodens farlighet (*Studie III och IV*).

I en subgrupp (n=479) jämfördes den prediktiva förmågan hos SIS med den rutinmässiga kliniska suicidriskbedömning som gjorts av läkaren i samband med indexförsöket, baserad på en sammanvägning av risk- och skyddande faktorer (*Studie IV*).

Totalsumman hos respektive skattningsskala användes som prediktor för suicidförsök och suicid under uppföljningstiden. Logistisk regressionsanalys,  $\chi^2$ -test och receiver operating

characteristics (ROC)-kurvor användes för att undersöka eventuella samband mellan prediktorer och utfall, och baserat på de tröskelvärden som identifierats i ROC-kurvorna togs sensitivitet, specificitet och andra mått på tillförlitlighet fram.

## **Resultat**

Det totala materialet utgjordes av 804 personer varav 541 kvinnor (67 %). Majoriteten (83 %) hade gjort ett suicidförsök vid index. Under det första året efter inklusion gjorde 216 personer (27 %) ett suicidförsök och 19 (2.4 %) dog i suicid.

I *Studie I* undersöktes den prediktiva förmågan hos KIVS bland de 355 personer som inkluderats 2012–2014 och som hade gjort ett suicidförsök vid index. Av dess gjorde 78 personer, 22 %, ett suicidförsök under det första halvåret efter inklusion. En totalsumma på sex poäng eller mer predicerade upprepat suicidförsök med 62 % sensitivitet och 53 % specificitet.

I *Studie II* undersöktes den prediktiva förmågan hos C-SSRS i hela gruppen om 804 individer med avseende på upprepat suicidförsök inom sex månader. Totalsumman och delskalan som mäter suicidtankars intensitet predicerade utfallet, med som bäst 59 % sensitivitet och 57 % specificitet.

I *Studie III* jämfördes de fyra skalorna med varandra med avseende på suicidförsök och suicid inom tre månader och inom ett år. Totalsummorna på KIVS, C-SSRS och SUAS var korrelerade till suicidförsök vid ettårsuppföljningen, och C-SSRS även vid tre månader. Totalsumman på SIS var korrelerad till suicid vid båda tidpunkterna. Den prediktiva tillförlitligheten var måttlig för alla skalorna.

I *Studie IV* jämfördes den kliniska riskbedömningen med SIS med avseende på prediktion av suicid inom ett år. Hög risk enligt läkarbedömningen var förknippad med utfallet med en oddskvot på 4,1 (95 % konfidensintervall 1,2–13,4) och hög risk enligt SIS (här definierad som en totalsumma  $\geq 18$ ) gav en oddskvot på 5,1 (95 % konfidensintervall 1,5–16,8). Båda metoderna hade måttlig tillförlitlighet vad gäller sensitivitet, specificitet och positivt prediktivt värde.

## **Slutsats**

Det finns statistiskt signifikanta samband mellan de faktorer som undersöks med skattningsskalorna och upprepat suicidförsök eller suicid. Trots det kan ingen skattningsskala predicera de utfallen på individnivå med tillräcklig precision till följd av otillräcklig sensitivitet och specificitet. Vad gäller fullbordat suicid är det ett ovanligt utfall också i en högriskgrupp, vilket innebär att endast en mycket liten andel av dem som identifieras som tillhörande högriskgruppen kommer att ta sitt liv. De faktorer som undersöks med skattningsskalorna är välkända riskfaktorer för suicidförsök och suicid och de patienter som ingår i studierna har i mycket hög utsträckning fått suicidpreventiva insatser. Detta kan innebära att det prediktiva värdet hos skattningsskalorna minskar, och att det inte skulle tillföra så mycket att införa skattningsskalorna i ordinarie vård.



Dessa resultat är i linje med ett mycket stort antal tidigare studier och talar för att suicidprevention genom identifiering av högriskindivider med hjälp av skattningsskalor inte torde vara en framkomlig väg. I detta arbete har skattningsskalor undersökts, men det bör poängteras att det inte heller med någon annan hittills undersökt metod har gått att ta fram prediktionsmodeller för suicidförsök eller suicid som är kliniskt tillförlitliga på individnivå.

De studier som ingår i avhandlingen ger däremot inte stöd för att skalorna helt saknar användningsområden, då det endast är det prediktiva värdet som är undersökt. De skulle t.ex. kunna fylla en funktion genom att strukturera och standardisera anamnesupptagningen.

Det går heller inte att, baserat på resultaten från de presenterade studierna, säga att suicidriskbedömning i sig saknar värde. Även om man inte kan förhindra alla suicid genom att förutsäga dem kan man identifiera påverkbara riskfaktorer och erbjuda behandling, om sådan finns. Att en riskbedömning är inexakt på individnivå är inte unikt för suicid. Detta gäller också för andra typer av dödsfall – skillnaden ligger i att suicid verkar uppfattas som mer förutsägbara trots att det saknas empiriskt stöd för en sådan ståndpunkt. Detta, liksom att det synes finnas ett behov av att hålla någon ansvarig när ett suicid inträffat är intressanta fenomen som ligger utanför den aktuella avhandlingens område.



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